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(J. A. BERLY'S).

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CAPITAL AND LABOUR IN AUSTRALASIA.

THOSE who are interested in the relationship of employers and employed in England are often glad to profit by the experience of other countries. In Great Britain the problems are many-sided and complex. The population is vast; there are infinite varieties of labour and sub-divisions of labour. What might be good for the cotton spinners of Manchester would be harmful to the shipbuilders of the Clyde; what might tend to ameliorate the conditions of the working classes in the electrical world, might only tend to disturb the relations of employers and employed in some other great department of industry.

If, however, it could be shown that in a less highly-developed community, State interference between master and man was of advantage to both, it might be worth the while of our Legislature to take definite steps in the same direction. From this point of view, a short examination into the system of compulsory arbitration in New Zealand, and the practical working of Wages Boards in the Colony of Victoria, is both interesting and instructive.

What are the facts? Some 13 years ago a system of compulsory arbitration was started in New Zealand. "You shall not strike; you shall not lock your men out," was the practical effect of the edicts pronounced to men and masters. Have these edicts been obeyed? In Victoria, Wages Boards have been established to fix, by arbitrary rule, the rates of pay in various trades. Has this led to better conditions for the working classes, increased efficiency, or a reduction in the cost of living?

To some of these questions a partial answer may be found in the pages of a Blue Book recently published under the auspices of the Home Office. Last year a Commissioner set forth to inquire into the industrial conditions in Australasia. His report is published in the work above mentioned. One fact stands out clearly amid what we must say, with all respect to the Commissioner, is a somewhat nebulous statement of the conclusions at which he has arrived. It is that things are still in an experimental stage. Even while he was pursuing his investigations, he found that fresh legislation was under active consideration in every State. "In no case, therefore," he writes, "was it possible to study the workings of legislation that was regarded as having reached its satisfactory and most appropriate form." Leaving his actual conclusions out of consideration for the moment, we should like to draw attention to some of the views put

forward by certain employers in the Colonies, whose opinions he sought. What do they think of compulsory arbitration?

Speaking generally, the New Zealand Employers' Federation does not think that the Industrial Conciliation and Arbitration Act has proved beneficial to either the worker, the employer or the consumer. The point that it is unfair to the community, in a protected country, is thus elaborated :—"If the judge of the Arbitration Court is not a very strong man the public as a whole is not represented, and it is possible for trades in which there is no outside competition for the masters and men to agree to an award which is unfair to the public at large." It is also pointed out that while the Court can enforce the awards against a master, it cannot do so against the men. That, to our minds, is the fundamental objection to the whole system. Who shall make a man work against his will? But it is only to a limited extent that an award can be enforced against the master. He cannot be compelled to employ anyone, nor can he be restrained from shutting down his works or moving them to another State outside the jurisdiction of the arbitration court.

To the work of the Wages Boards there are also objections, the validity of which must be manifest to all who have an inkling of the first principles of political economy. It appears, however, that many of the employers in Victoria are favourable to the existence of these bodies on the ground that they prevent sweating, and do not appear to press hardly on the small employer. They have, however, encouraged the use of machinery, increased the sub-division of work, and diminished the efficiency of employés. This last finding is corroborated by the Attorney-General of New Zealand, who, in the course of a speech recently reported in the *Times*, stated that "the production of certain workers in one industry had decreased 15 or 20 per cent. as the result of uniform wages."

Again, the employers in New Zealand are of opinion that their effect has been to depreciate the quality of the work done; to increase the cost of production; to disturb the harmonious relations between master and man; and lastly, but not least, to increase the cost to the consumer.

Finally, the view has been freely expressed, and the Commissioner who has drawn up the Blue Book confirms the opinion, that Protection and State interference between capital and labour must go hand in hand. In a Free Trade country it would be impossible.

Regarding the findings of the Commissioner and the evidence before him as a whole, one is impelled to the conclusion that these experiments have been futile even in countries which are thinly populated, which have been enjoying a period of commercial prosperity, and in which commercial relations are comparatively simple. But if further evidence is necessary, one need only quote the opinion of Mr. Ramsay Macdonald, who recently studied these questions on the spot for himself. He says that "on the most generous estimate it—the Act (in New Zealand)—has been calculated to have raised wages by about 8½ to 10 per cent., but the cost of living has at the same time increased between 15 and 30 per cent." Seeing that the worker has to live as well as work, it seems to us that to decree higher wages which involve increased cost of living is like "feeding a dog with a bit of his own tail."

If this be the result in the Colonies, what would be the effect at home? Here, active competition would prevent the employer from shifting the burden on to the consumer. If the State were to fix a minimum wage, or to decree that strikes should be ended on certain terms, employers would have no alternative but to shut down their works.

Electro-Mechanical Propulsion of Steamships.

AN interesting paper was read on Saturday evening by Mr. W. P. Durtnall, before a meeting of the Institute of Marine Engineers at the Congress Hall at the Franco-British Exhibition. The attendance was not so large as could have been wished, considering the importance of the subject, and the discussion was, therefore, postponed, so as to give members an opportunity of reading the paper. A large number of slides were shown, illustrating the development of marine practice since the date when the *Great Britain* was equipped with a two-cylinder engine working at 18 R.P.M., and at a steam pressure of 6 lb. per sq. in. This engine, it is interesting to note, drove the screw by means of a chain gear having a ratio of three to one, and the ship took about 15 days to cross from Liverpool to New York. This was contrasted with the latest marine practice; illustrations of the *Mauretania* and *Lusitania* were shown, and some details were given of the engine room equipment.

One of the principal disadvantages of the steam turbine-driven ship is the reversing difficulty. Auxiliary turbines have to be provided for reversing, and these are necessarily only of comparatively small power. According to the author of the paper, on short voyages, turbine-driven ships lose in reversing and manœuvring most of the time gained by increased speed in the passage, and it was pointed out that this disability would be even more serious in naval vessels than in the merchant service.

As regards steam consumption, it was pointed out that satisfactory as are the results obtained with marine turbines as compared with reciprocating engines, the highest possible efficiency cannot be obtained owing to the fact that the turbine has to be run at a speed lower than its best speed, owing to the inefficiency of the propeller itself at high speeds. The propeller is essentially a low speed, and the turbine a high speed device, and a compromise has to be made to get the best results from the combination. Another disadvantage is the serious falling off in efficiency at reduced vessel speeds. In the tests of the *Lusitania* the steam used by the turbines, including auxiliaries, was 14·46 lb. per shaft H.P. when running at 25·4 knots; and 26·53 lb. at 15·77 knots—an increase of over 80 per cent. per shaft H.P. for a reduction of about 38 per cent. in vessel speed.

This consumption may be compared with the consumption of a turbo-electric generator working at its best speed with a steam pressure of 160 lb. per sq. in. and 150° of superheat, and 27½ in. vaccum. Under the above conditions the steam consumption of a 7,500 KW. set running at 750 R.P.M. was given as 13·5 to 14 lb. per KW.-hour. In larger sizes this consumption can be materially reduced. It will be noted that the steam consumption per KW.-hour is practically the same as the consumption per shaft H.P. in the much bigger sets of the *Lusitania*. This is really the crux of the problem, and Mr. Durtnall claims that by using turbo-generators, driving electric motors coupled to the propeller shafts, the turbine and propellers could be run at their most efficient speeds and a saving in coal consumption of upwards of 41 per cent. at full speed, and about 37 per cent. at half vessel speed could be secured, reckoning on sizes of 1,000 H.P. only.

The weight of the equipment would, the author estimates, amount to about 25 per cent. more than the equipment for an ordinary turbo-driven ship, and this could be distributed with advantage. There would be no need to have the boilers and generating sets close up to the shaft tunnels. The motors, of course, would be fitted as close to the propellers as possible, but the generators can be put further forward so as to get a better distribution of the weights.

The author claims that the saving in the fuel consumption would be such as would permit of a ship of the same size as the *Lusitania* being built with three funnels instead of four.

Nothing was said in the paper as to the probable cost of the equipment, but any saving in fuel consumption which resulted from the electro-mechanical system would have to be set against the increased capital charges of the equipment.

Mr. Durtnall informs us, however, that owing to the smaller turbines required for an equivalent power, the elimination of reversing turbines, and reduction of condenser and boiler capacity, the total cost will, according to his calculations, be practically the same as under the present system.

As regards the electrical side of the proposals, these will be given in an abstract of the paper itself, which we hope to publish at a later date. We have no doubt that a very interesting discussion on the proposals will take place at the forthcoming meeting.

Symbols for Physical Quantities.

The article by Mr. Miles Walker, which appears elsewhere in this issue, merits the attention of all who have to do with engineering under modern conditions. We do not envy Mr. Walker in the task which he has been commissioned to undertake; to devise a new set of symbols, distinct from each other and from existing types, and satisfactory to the numerous and diverse interests concerned, is a problem by no means easy of solution. It will be seen that the symbols are intended to convey to the eye by their forms, the ideas which they respectively represent, being thus symbolic in the strictest sense; but whether in the abstract or the concrete appears, as yet, to be indeterminate. We are accustomed to the sign "ω" for "ohms," but it is rarely if ever used to represent this quantity in a formula—and it is particularly in formulæ that symbols are required. If it is used in a formula, it is called omega, just as x is called eks. Surely it is more convenient, and quite as intelligible, to say C equals E over R, than to say Amperes equals Volts over Ohms? We need not multiply examples, though it would be easy to adduce some terrible ones; the principle that we wish to emphasise is that each symbol should have a name of its own, other than that of the thing it represents. When one is working with symbols, one does not require, and, indeed, it is not practicable, to form a mental picture of the things represented, or of the processes through which they are symbolically passed. What idea, for instance, does the process of dividing volts by ohms convey to our minds? As a matter of fact, we do not carry out this process; we deal only with the numerics corresponding to the values of the quantities dealt with, in the manner laid down by the formulæ, and the various mathematical transformations through which the formulæ may pass could be carried out quite as easily and accurately by a person who had not the faintest idea what the symbols stood for, provided that he was informed as to their relations with one another. The relations between magnetomotive force, flux and reluctance, are similar in form to those between potential difference, current and resistance, but the quantities concerned really differ widely in their characteristics, though they are handled alike for certain purposes.

As was pointed out at a meeting of the Civil and Mechanical Engineers' Society, when discussing this question not long ago, few engineers have occasion to deal with more than a very limited range of quantities and formulæ; it would suffice, therefore, that within the scope of each subject the symbols (for which at least 100 different letters and types are available) should be organised so that each is not used more than once; the fact that the same symbols were used again in other branches of science or engineering with other significations would be of little consequence.

We fail to see the necessity of new symbols, and we believe that the task of designing and introducing them will be Herculean.

Public Authorities' Protection Act.

The case of Moss *v.* Salford Corporation, which was tried a few days ago before Mr. Justice Bucknill and a special jury at the Manchester Assizes, affords an illustration of the way in which local authorities are favoured by the Public Authorities' Protection Act, 1893. The action was brought to recover damages for injuries alleged to have been sustained in a tramway accident on July 9th, 1907. The Corporation first heard of the accident on November 9th, 1907, and the writ was not issued till March, 1908. The Corporation relied on the statutory defence that the action was not brought in time. The Act provides that "Where any proceeding is commenced in the United Kingdom against any person for any act done in pursuance or execution, or intended execution, of any Act of Parliament or of any public duty or authority, the proceeding shall not lie or be instituted unless it is commenced within six months next after the default complained of, or, in the case of a continuance of injury or damage, within six months next after the ceasing thereof." It was urged that this defence could not be raised, inasmuch as the injury was of a continuing nature, and that, therefore, the action was not launched too late. The judge, however, feeling bound by authority, was compelled to dismiss the action. He expressed the view that the case was one of some hardship, and granted a stay of execution. It is always argued with some show of reason that, in the performance of its strictly public duties, a local authority is entitled to this kind of protection. But in running tramways at a huge profit to the ratepayers it is difficult to see why it should enjoy greater privileges than those which are extended to the shareholders of an ordinary tramway company.

Rail Corrugations.

The interesting paper read by Prof. Carus-Wilson at the Tramways Congress, describing his experiments on the corrugation of rails and the conclusions deduced therefrom, deserves close attention on the part of tramway engineers. While the theory put forward can only be regarded as a working hypothesis, it appears to be well supported by observed phenomena, and cannot be dismissed offhand. The fact that so many conditions must be present in order to bring about rail corrugation is very significant, and may account for the apparently contradictory reports which have been recorded. It seems desirable that careful investigations should be made on the lines laid down by the lecturer, in order to ascertain in each case where corrugation has occurred whether all the conditions are fulfilled—and where corrugation is absent, whether one or more of the necessary conditions are wanting.

D

LOCALISING HIGH-RESISTANCE BREAKS IN CABLES.

By J. RYMER-JONES.

Introduction.—Although there are several very good tests in common use for localising breaks which expose more or less conductor to the sea water, it is generally recognised that, if the conductor end be buried in stiff mud, coated with a hard incrustation, partially sealed, or finds *earth*, through the water contained in an inch or so of insulating tubing, tests based on Kennelly's law, or modifications of it, do not in the least apply.

When confronted with a high-resistance break of a few thousand to 40,000$^{\omega}$ or 50,000$^{\omega}$, it is no exaggeration to say that even the most experienced cable electrician feels almost helpless, for it is not always possible to open the fault sufficiently by applying a strong current, even if the normal insulation of the cable and joints permits this; and it is a serious predicament when the responsible man is unable to tell within 100 miles or so where the ship should cut in to effect the repair.

It was in consequence of this difficulty arising—especially in connection with the Amazon River cable, where break resistances of 20,000$^{\omega}$ are occasionally met with—that the writer devised the test, published in the ELECTRICAL REVIEW of June 7th and 14th and July 5th, 1901, which he has now revised and simplified.

In so far as this method requires a measurement of the broken cable resistance, and also of the charge which the cable portion of the circuit holds under the special conditions of testing, the principle involved is very similar to that on which Mr. H. R. Kempe bases his test, for the same object, first described in his "Handbook of Electrical Testing," Second (1881) Edition, page 308. It will be seen, however, that the method about to be described differs widely from that of Mr. Kempe as to the manner of making the tests, compensating for the cable current and working out the results. Indeed, no formula at all is employed beyond that required for an ordinary cable C.R. test by *direct deflection* method and for a capacity test by *charge* method.

The position of the break is evaluated from the results of these tests by the help of very simple tables, in connection with which only a *simple proportion* sum is required for greater accuracy than the tables alone afford.

Although the required data are obtained by very simple methods, the test is, of course, not equally easy in practice. Indeed, it would be as unreasonable, when testing to a break which varies greatly owing to ebullition of gas, to expect *steady* results, as when localising a high-resistance *earth leak* in an unbroken cable by the simple and efficient "fall of potential" test. In both cases reliable results can only be obtained by exercising patience and by repeated trials. That the test is sound in principle and capable of giving correct results is proved by the annexed examples.

Localising High-Resistance Breaks in Cables.—This test includes a measurement of the cable *circuit resistance*; of the *charge* taken up by the cable portion; of the *cable current*, as well as the *constants* required for resistance and capacity. All of these are made with a galvanometer connected up in the ordinary way, with the sole exception of the *charge* measurement, for which a galvanometer is employed having its coils equally divided, so that each half of the turns exercises an opposite influence on the suspension when connected up in parallel circuits to act differentially. This arrangement is preferred because, although a *bridge system* is practicable for the charge measurement, and thus admits of a *single-coil galvanometer** being employed, yet it involves important disadvantages (see *Principle of Test* in Explanatory Remarks).

Obviously a correct result is the first consideration, and this can only be expected when the charge measurement is made under the best conditions. For this reason it is highly desirable that these difficult localisations be made when possible from the shore, and also from the end nearer to the break.

Preliminary Measurement of the Total Resistance of the Cable Circuit.—This resistance (R *l*) is not only required as one of the data for the test, but the knowledge of its approximate value assists in quickly finding the galvanometer balance, with R *b*, necessary for the capacity test described later on, and it is therefore ascertained first by any method preferred.

As R *l* will, in the case of some high-resistance breaks, change, its value should be re-determined after the *charge*, and other data for capacity have been obtained.

To Obtain the Balance (see fig. 1).—Put plugs in holes 1 and 4 of commutator B, and also plug 5 in commutator A to connect K_2 with the junction (J) of the galvanometer coils; then, leaving K_1 and K_3 in the position shown, move both

FIG. 1.

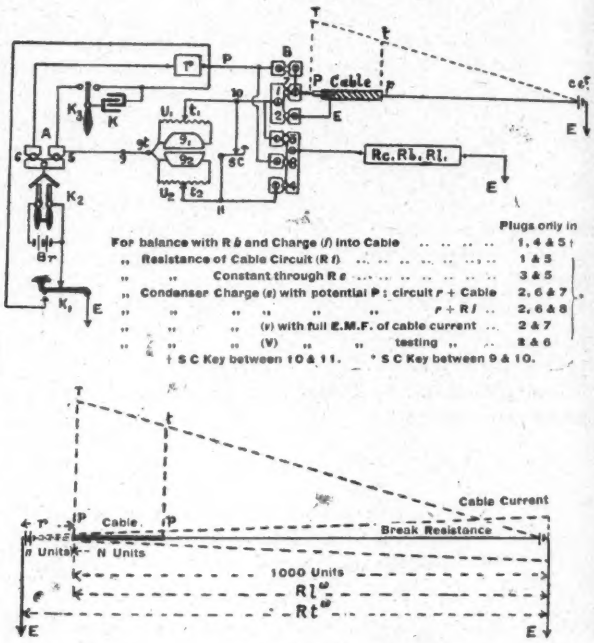

T
t
P
B
P Cable P
C
E
K3
K
U1 t1
A
g1
g2
SC
Rc. Rb. Rl.
K2
U2 t2
H
Plugs only in
For balance with R b and Charge (f) into Cable .. .. 1, 4 & 5 †
,, Resistance of Cable Circuit (R l) .. .. 1 & 5
,, ,, Constant through R c .. .. 3 & 5
,, Condenser Charge (c) with potential P; circuit P + Cable 2, 6 & 7 *
,, ,, ,, ,, ,, ,, P + Rl .. 2, 6 & 8
,, ,, ,, (c) with full E.M.F. of cable current .. 2 & 7
,, ,, ,, (V) ,, ,, testing ,, .. 2 & 6
† S C Key between 10 & 11. * S C Key between 9 & 10.

FIG. 2.

handles of K_2 to the right to put the *negative* pole of testing battery through g_1 (shunted with U_1) *via* plug 1 to cable; and also through the parallel circuit g_2 (shunted with U_2 equal to U_1) *via* plug 4 to the resistance coils R *b* and earth.

Note that the positive pole of the battery is to earth through K_1, and that the short-circuit key is between points 10 and 11.

Adjust R *b*—or alter shunt U_2—until equilibrium is established between this and the parallel circuit. Both coils g_1 and g_2 should have *universal shunts* capable of being varied as desired.

As equilibrium is being perfected by R *b*, increase, if necessary, the resistance of both the shunts, which should be of such a value as will afford a good throw, say, 300 or 400 divisions, when subsequently observing the *cable charge*.

The testing current must be suited to the resistance of the break to obviate as much as possible unsteadiness due to excessive generation of gas at the broken end.

As a change in the *balance* has to be compensated by R *b*, or by U_2, the former had better be a resistance with a *sliding* contact (not *plugs*) capable of being adjusted quickly without breaking the circuit; or, if a slide resistance be not available, R *b* may be a *fixed* resistance and the balance obtained by adjusting the shunt U_2 (see *Short-circuit Key* in General Remarks.)

When the balance is effected depress K_1 quickly. This cuts off the testing current by removing the *earth* from the positive pole of the battery while the cable is being discharged direct to earth, for (say) two seconds, through the lower front contact of K_1. Then allow K_1 to rise and thereby put the testing current on again. Note the *cable charge* throw (C) due to the "fall of potential" when the current is re-applied, and also the shunt M P on g_1.

To prevent any important disturbance of the galvanometer balance by the *cable current* passing through g_1 or g_2, while K_1 is moving from its lower to its upper contact, the distance between these contacts should be very small. The

* See *Galvanometer* in General Remarks.

ordinary "trigger" form of *discharge key* is very suitable for K_1.

Although the *prolonged* testing currents through g_1 and g_2 have, after the first few seconds, been made to equilibrate each other by means of R *b*, yet the balance will be momentarily upset at the instant of re-applying the battery through K_1 by the amount of charge taken up by the *capacity* of the cable. The testing current for this need only be kept on long enough to observe C.

If successive throws vary, a *series* of charges should be observed by alternately depressing K_1 to discharge the cable and then allowing it to rise to re-charge the cable. Accuracy will depend on a sufficient number of readings being taken to secure a true *mean* value for C.

(Re *charge readings* (C) see *Polarisation of the Break* in Explanatory Remarks.)

The fact that the balance remains steady between throws will show that the *break resistance* and *cable current* are also steady; but if R *b* (or U_2) has to be varied to maintain an approximate balance, the value of R *l* should be re-measured by direct deflection (as explained later on) before commencing another *series* of readings.

To Obtain the Condenser Constant.—Change plug from 5 to 6 of A, and from 1 to 2 of B. Also put a plug in hole 7 (see fig. 1), and, when making all the following measurements required for the test, connect the short-circuit key between points 9 and 10, *i.e.*, between terminals T and T G of U_1 on g_1, which alone is required for the remaining measurements; g_2 being in circuit for the *charge* measurement and *balance* only.

For this *constant* the adjustable resistance *r* is made equal to the galvanometer coil g_1 *as shunted for the cable charge test* (see *Shunts* in General Remarks).

On moving the handles of K_2 to the right, the negative testing current circulates through *r* and through the cable to earth. If the handle of K_3 be now switched to the right, the condenser K is charged from point P through the galvanometer coil g_1—shunted if necessary—which is to earth through plug 2 of B. Turning the switch handle to the left puts the condenser on short-circuit to discharge it. Note the condenser charge throw (*c*) and any shunt *m p* employed.

If the condenser charges vary considerably—as is frequently the case, owing to the testing current affecting the break—another *constant* may be observed later on when a resistance equal to the calculated value of R *l* is substituted for the cable by moving the plug from 7 to 8 of B.

$$\text{Charge taken up by the cable} = \text{K}\,\frac{\text{C} \times \text{MP}}{c \times m\,p}\,\text{mfds.}\quad (f)$$

(See *Reproducing deflection d and charge throw c* in General Remarks.)

Cable Current Correction to be Applied to Cable Charge (*f*).—After taking a few readings *c*, as explained above, and while still keeping the testing current on with K_2, remove plug 6 from A and cut off the testing current. Then turn handle of K_3 to right to charge the condenser from the *cable current* through g_1, and note if the throw (*v*) is on the *same side of scale zero as c or not.* Next take out plug 7 from B and replace 6 in A, and then observe the charge (V) into the condenser with the *full* E.M.F. *of testing battery.* It is advisable to observe *v* before V so that the cable current may change as little as possible after obtaining the cable charge (C) and condenser *constant* throw (*c*). The same shunt should be used for *c v* and V, and in that case the *ratio* between the cable current and testing current E.M.F. $= \frac{\text{V}}{v}$. This ratio will be required to correct the above calculated capacity (*f*), employed for evaluating the *first* calculated distance of the break, for the influence of the *cable current.* (See *Cable current correction* in Explanatory Remarks.)

To Measure the Total Resistance (R *t*) *of the Cable Circuit by Direct-Deflection Method.*—This measurement should be repeated as follows at the end of the foregoing observations to ascertain if any marked change has occurred, and if so, another series of readings for C, *c*, *v* and V should be made.

With plugs only in 1 and 5 (see fig. 1), and retaining the short-circuit key between points 9 and 10, move both handles of K_2 to the right to put the *negative* current to the cable through g_1 shunted suitably by U_1. Note the deflection (*d*) and the shunt value (*m p*), then switch handles of K_2 to the left and observe the cable current (δ) which is to be added to *d* if on the opposite side of the scale zero, or subtracted if on the same side, in order to obtain the corrected deflection for calculating the true resistance (R *t*) of the cable circuit, including the resistance of the battery (B *r*) and of the shunted galvanometer coil g_1 (*r*).

The *constant* for this test is taken—after the other localisation measurements are concluded—by keeping in plug 5 of A and changing the plug from 1 to 3 of B. Move handles of K_2 over to the right to put the testing current through g_1 (suitably shunted) and high resistance R *c* to earth. Note deflection (D) and the M P of shunt.

Resistance in circuit

$$\text{R}\,t = \text{R}\,c\,\frac{\text{D} \times \text{M P}}{(d \pm \delta)\,m\,p}\ \text{ohms.}$$

Resistance of cable conductor and break

$$\text{R}\,l = \text{R}\,t - [g_1\ (\text{shunted})^* + \text{B}\,r].$$

Alternative for Measuring the Total Cable Circuit Resistance (R *t*).—This is a little more expeditious when the break varies greatly and re-balancings for repetitions of the charge throw C are frequent.

After obtaining a balance with R *b*, switch both handles of K_2 to the left, thus putting both galvanometer coils g_1 and g_2 direct to *earth*, *via* 9, 5 and key K_1.

Note the *cable current* deflection, and after putting the testing current on again with K_2 re-balance to this *false zero* with R b_1; R b_1 will then equal the true cable circuit resistance R *t* (÷), and the difference between R *b* and R b_1 is the resistance effect produced by the cable current.

Correction (÷).—If the resistance of the cable circuit be measured as above instead of by *direct deflection*, the two halves of a *doubly-wound* Sullivan galvanometer coil will equalise each other very closely, but this is not likely to be so with a Kelvin galvanometer converted to a differential use. It is only necessary, however, to put a resistance R_1 (approximating that of the cable break) in circuit with g_1 and to adjust coils R b_2 to get equilibrium when testing with one cell.

If g_1 and g_2 are both equally and suitably shunted for obtaining the charge throw C while this balance is obtained, $\frac{\text{R}\,b_2}{\text{R}_1}$ gives the *ratio* wherewith any subsequent balancing may be corrected for the difference in effect of g_1 and g_2 on the galvanometer suspension.

(*To be continued.*)

SYMBOLS FOR PHYSICAL QUANTITIES.

By MILES WALKER.

It is very desirable to have a notation for the representation of physical quantities in scientific books and periodicals, which shall be the same in all languages.

The subject is under the consideration of the International Electrotechnical Commission with a view to international agreement, and committees in the different countries (in England under the chairmanship of Lord Rayleigh, O.M.) are discussing this particular subject. They are dealing more especially with symbols for electrical and magnetic quantities, but the system might with advantage be extended to embrace all important quantities in physical science, especially as the subject is receiving the attention of most technical societies with a view to some action being taken in the matter.

There are, however, two great difficulties which arise when we try to fix upon a standard notation.

The first is the difficulty of persuading a number of writers and readers, who have become accustomed to a certain symbol for a certain quantity, to change it in favour of an equally large number of writers and readers who have become accustomed to another symbol. For instance, in France and Germany the letter "I" commonly represents the strength of an electric current, while in England and America "C" is more commonly used.

In the second place, there are not enough letters in the two or three alphabets at our disposal to give a distinct

* See *Resistance of Galvanometer Coil* g_1 *as shunted* in General Remarks.

symbol to each quantity, without resorting to the combination of more than one letter to form a single symbol. There is a great objection to this combination of letters, because the use of subscript letters and numbers is required for distinguishing between particular quantities of the same general kind. If, for instance, C represents current, C_a might conveniently represent armature current, and C_1 the current in circuit No. 1. It would therefore not be good to take C_a to represent capacity, or any quantity other than an electric current.

There is, moreover, an objection to using letters at all to represent quantities in a universal notation, because, unless initial letters are used, there is no connection in the mind between the letter and the quantity, and the symbol is difficult to remember. We cannot always use initials, because the initial letters differ in different languages. For instance, in England "R" commonly stands for resistance, while in Germany it is more convenient to use "W" for widerstand. Moreover, the same initial occurs for a great number of different quantities. For instance, "R" might stand for Resistance, Reluctance, Reactance, Radius, &c.

One way of avoiding the above difficulties would be to create a number of new symbols which could be printed by means of type, like ordinary letters, and which would represent each physical quantity in a distinctive manner.

The question, however, arises as to whether a number of entirely new symbols would be acceptable to writers, readers and printers alike, and the Sub-Committee on Symbols appointed by the British section of the Commission, has requested the writer to place his views publicly before the Profession, with a view of obtaining suggestions and criticisms as to the feasibility of such a scheme from as wide a circle as possible.

In choosing a symbol, we would try to make a very simple picture of something that reminds us of the quantity in question. For instance, ⌇ might represent temperature. If we were told that this simple outline of a thermometer represented temperature, we would have no difficulty in remembering it. Similarly, / might represent Force, and the various "Forces" might be derived from it; for instance, ϟ electromotive force (conventional representation of lightning), and ∩ magneto-motive force.

It is not my purpose here to say what would actually be the best form of symbol for each quantity, but it is not a difficult matter to devise very simple characters which can be written quickly, easily and with sufficient accuracy, and which can at the same time assist the memory to connect them with the quantity for which they stand.

What would the printers say to the new type? The author has taken up this matter with a very large publishing firm, and is assured by their chief expert that 200 or 300 new type would be a small matter to a modern printer, who is already accustomed to deal with many hundreds of different founts, each of which contains from 30 to 120 different symbols. He estimates that a printer in a large way of business has at his command as many as 60,000 distinct type, differing from each other either in letter, size, body or face. The addition of 200 or 300 more would be a drop in the ocean. The size of the new type could be standardised for most purposes, and it would only be in some special case that another size would be called for.

The setting up of the formulæ with the standard size of type would be simpler than with the present system, in which sub-script letters are often unnecessarily introduced. One symbol under the present system sometimes consists of four or five letters.

If it be admitted that the introduction of new symbols is advisable, the question arises, What shall the new symbols represent exactly? Shall the sign ⌇ (Temp.) represent Temperature in any units, or shall it represent the number of degrees of temperature, measured by some scale agreed upon, and embodied in the definition of the symbol. If the system of units employed were not prescribed, fewer symbols would be required, and the general writer who now says vaguely "Let T equal the temperature," would find the symbol sufficient for his purpose. But from the reader's point of view, there is much to say in favour of a symbol which will embody in its definition a standard system of units. Any formula expressed in such symbols would be completely self-contained, and would be an exact statement of a physical fact. Until the units employed in any formula are known, the formula expresses only half its meaning. Perhaps some slight addition to the symbol, or even to the whole formula, might be used to indicate that the standard system of units was employed. Without that addition, the symbol would have a general meaning. For instance, ⌇ might equal temperature, while ⌇ might indicate the degrees Centigrade above the absolute zero. The name of the type might be the name of the physical units which it represents; for instance, for ϟ we might read "volts."

If writers, printers and readers, who have any definite views as to the best method of devising a system of symbols, would communicate with the technical Press, or with the author, they might assist in solving the many difficulties which arise in connection with this matter.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The Commercial Efficiency of a Testing Department.

The paper by Mr. H. A. Ratcliff on "The Work and Equipment of a Testing and Standardising Department" (an abstract of which appears on later pages) raises some very important subjects for discussion. One of the most important points raised, and one, the settling of which would have the most practical and far-reaching results, is how is a chief engineer to know when his testing department is getting beyond the "valuable financial asset" stage to the "scientific luxury" one. It is not to be expected that many central station engineers have a clear grasp of all the work of a well equipped testing department. They have many other departments under their care, and to master all the details of every department of a fairly large supply system is an absolute impossibility. With the exception of a few large towns similar in size to Manchester which are obliged to have a large staff and can easily afford a handsomely equipped testing department, money is, as a rule, spent very sparingly on testing instruments, and the staff is kept down to the minimum. To carry this economy to the extreme is financial folly. It is as important to be absolutely certain that every unit used by a consumer is properly measured and paid for, as it is to measure the coal that is delivered at the works to be converted into electrical energy. Many chief engineers would undoubtedly be surprised if the accuracy of the meters in use were carefully investigated at different loads. In many stations absolute reliance is placed on the meters being accurate when received from the manufacturer's works. This will most likely result in considerable loss to the supply authority for the following reasons:—The type of meter may be most unsatisfactory, as, having no meter tester on the staff, the engineer is obliged to take the statements as to the accuracy of the meters offered him by the manufacturers as correct, and they can hardly be expected to get any but the most perfect results. The meters may be rendered inaccurate by the rough usage in transit, but this may be got over by having a man from the maker's works to go through each batch as they arrive, and repair the bad ones. This is still an unsatisfactory arrangement, as the meters will only be subjected to those tests that yield the most accurate results, for the man has his employer's interests to serve, and these differ from the supply engineer's interests. Then again, if the type of meter is changed, the original manufacturer will charge dearly for the testing and repair of meters that have been in use for a little time. Enough has been said to show that it will pay all engineers except those in charge of very small stations to have apparatus sufficient to test all the meters at various loads, and a man of sufficient ability and leisure to make these tests. The very small stations that are near enough to a large station should adopt Mr. Ratcliff's suggestion, and get their meters tested for them.

A meter manufacturer who knows that his meters will be subjected to severe tests on arrival, will either of his own free will or otherwise, see that the meters are carefully

assembled and tested before despatch. In these days of low candle-power lamps (5 C.P. or less), it is most essential that meters should register their currents correctly. In A.C. systems, with the extensive use of 25-volt transformers for metallic-filament lamps, the supply authority will lose a large number of units if the meters fail to register the small but continuous magnetising currents taken by these devices. Large power meters with a high starting current are another source of loss, as frequently several motors are kept working after the majority are shut down and the current taken by these may not be registered at all.

With reference to the testing and repairing of instruments, recorders and clocks, &c., only the larger stations will be able to afford the necessary apparatus and skilled staff to do this work. The same applies to a chemical laboratory.

As to the value of equipping a testing department with photometric appliances, Mr. McCourt read a very good paper on this subject last year before the same association. If a system of testing all lamps used by consumers is adopted, as at Harrogate and other places, then suitable apparatus and staff are absolutely necessary. Engineers differ greatly in opinion as to the advisability of this course, and undoubtedly many look upon all work of this description as a scientific luxury. A well-equipped photometric room, as at Manchester, will certainly be of great help in fighting the gas interests, and where the competition is very keen, may be a financial help to the undertaking. Any station of moderate size will derive some benefit from the addition of the simple apparatus necessary to enable candle-power and life tests to be made of all new types of lamps, and if much street lighting is done, a portable photometer will also be of use. The effect of different types of reflectors and shades can be ascertained, and sound advice offered to consumers who are dissatisfied with their lighting.

In his paper Mr. Ratcliff describes a simple arrangement for the periodical testing of live networks. There are several types of apparatus on the market for conducting tests of this nature, and many engineers will have had experience of their use. It would be interesting to hear from them as to whether this testing of the distributing system had proved of any practical value. If slight defects on the cables are indicated and can be located and repaired before they develop into bad faults, then the number of serious breakdowns on the mains will be reduced, and the cost of the apparatus and time spent in testing will be amply repaid. It is to be feared, however, that, whilst the instruments will readily show a fault developing on a part of the network, it will only be with the greatest difficulty that this fault can be located to a particular cable before it assumes a serious aspect. The high pressure testing set described in the paper for breaking down small faults can, of course, only be used when the particular cable is found and made dead.

Conductivity tests on newly arrived drums of cable might be of service, as nearly every engineer at present places implicit reliance on the honesty of cable manufacturers, and possibly in a few cases this confidence may be misplaced.

The author's remarks on fault localising are very good, and certainly the simplest apparatus will generally give the best results. Small portable accumulators are rarely of any use for this work, as the pressure they give is generally insufficient to send any appreciable current through the fault.

Where a supply authority hires out motors, some simple tests before sending them out will save a good deal of trouble. If motor and starter repairs are undertaken by the staff, suitable apparatus and arrangements for rapidly finding the faults and testing when they have been repaired, will be absolutely necessary. Mr. Ratcliff's description of the method employed at Manchester for testing motors under varying loads strikes one as being very economical and effective. As he states in his paper, elaborate efficiency tests are only a waste of time, with the possible exception of the test of a sample motor from the contractor for the year.

The testing of switches, fuses and similar apparatus is neglected in most stations, and, perhaps, rightly so, as the best tests for these things are time and ordinary wear and tear. Manchester had, and perhaps still has, some system of testing these fittings, and recommending them to consumers as being approved of by the Corporation. The author makes no mention of this in his paper. If this can be successfully done, and only competent contractors allowed to do work in a town, electric lighting would never get into disrepute.

Each engineer can divide the work of his testing department under two heads—testing that is absolutely necessary, and which will bring in an immediate financial return, and testing that will either tend to prevent interruptions to the supply of current, or probably bring in some financial return in the future. Mr. Ratcliff's paper will then be of considerable help to the engineer, in deciding first of all whether his testing department is efficiently equipped with apparatus and men to carry out work under the first head. This accomplished, provided he has sufficient funds and enterprise, the work under the second heading can be undertaken to a greater or less degree as his judgment decides.

The Work and Equipment of a Testing and Standardising Department.

By H. A. Ratcliff (Associate Member) Assistant, Manchester Corporation Electricity Works.

(Abstract of paper read July 3rd, 1908.)

The importance of a well-equipped testing department is beginning to be realised, for by the judicious testing of mains, meters and distributing apparatus generally, the proportion of units sold to units generated may be considerably increased. In the case of small stations, where it would not pay to equip fully a testing department, the work should be carried out by a larger neighbouring authority; the Manchester Corporation, for instance, tests and calibrates a considerable number of meters for other authorities, at moderate though profitable rates.

The steady currents necessary for accurate testing are best supplied by accumulators, for D.C. work. At Manchester there are two classes of cells for this purpose; one for tests requiring a small current at pressures up to 500 volts, the cells having a maximum discharge rate of 6 amperes, and being divided into five sections of 100 volts each; and the other for heavy work, using large cells in groups of 10, each feeding a separate panel.

In the case of the former, the first section is sub-divided, as in fig. 1, and with the aid of a battery of larger auxiliary cells and a potential divider, any voltage from 0·2 to 500 volts can be obtained, in steps of 0·2 volt—2,500 steps.

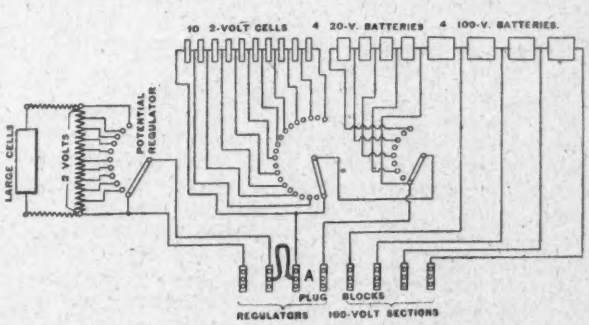


Fig. 1.

For the larger currents, 10-cell units were chosen because experience showed that 20 volts was the lowest pressure that could be conveniently used.

Under no conditions does any unit ever feed more than one circuit at the same time, lest alterations in one should affect the current in the other. With the existing arrangements the current, once set, will remain constant long enough to enable a row of 20 meters to be tested without readjustment.

The best source of A.C. supply is a small motor three-phase generator combination. Inverted rotary convertors are occasionally used for this work, but they are not so convenient as the motor-driven generator.

Regulation of testing current and voltage, &c., should be centralised as much as possible, in preference to having switches, resistances and instruments, &c., scattered about the test rooms.

For the actual control of heavy currents, rheostat switches connected with wire resistances, constitute the most satisfactory arrangement; water and carbon resistances are by no means so convenient.

A range from $\frac{1}{100}$th of an ampere to 1,000 amperes may be obtained with comparatively small resistance frames, if suitably designed. The frames may be connected up to the rheostat switches controlling them, either in series or parallel; there are many

objections to the first method, and though the parallel controllers are rather more expensive, they are far more reliable in their working, and, moreover, the increased cost is not so great as may be supposed.

A very convenient arrangement is to have the rheostats in three groups, as follows:—

One group having	10	approximately	1-ampere steps		
"	"	10	"	10	" "
"	"	5	"	100	" "

These would all be connected in parallel with a resistance capable of carrying a maximum current of 1·5 amperes, and having a practically infinite range of variation; about the most convenient resistance of this type is the "Kelvin" drum rheostat.

It is convenient to be able to adjust the current, volts and power factor, separately and without appreciably altering either of the other quantities, also to be able to make slight adjustments of the watts without altering current, volts or power factor to any great extent.

The following diagram, fig. 2, shows an arrangement which has been found to be very convenient for all classes of A.C. meter and instrument testing.

The voltage of the alternator may be varied from practically zero up to 450 volts. The fine control rheostat in the alternator field can be used for maintaining the watts in the testing circuit absolutely constant, since, by moving it, slight variations are produced in both the current and the volt circuits, but not to a sufficient extent to be of any consequence, although quite sufficient to give the necessary adjustment of the watts.

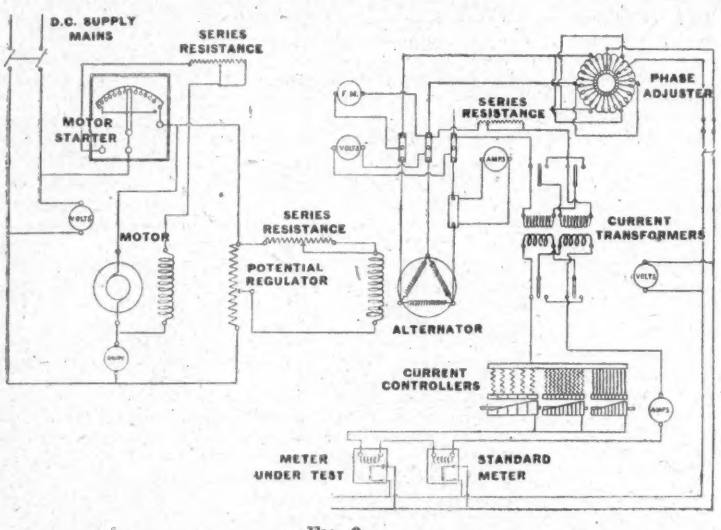


FIG. 2.

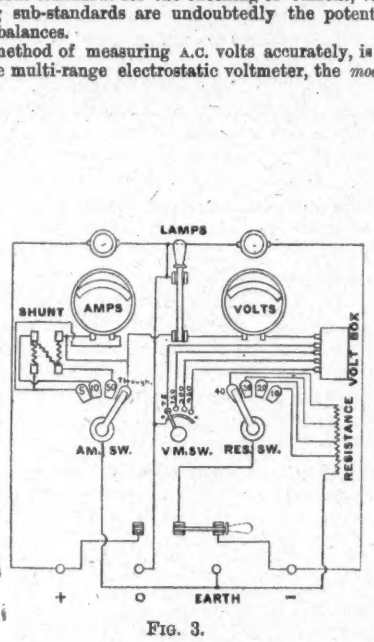


FIG. 3.

The main current circuits are controlled in the same way as in D.C. work, except that the fine control is obtained by a resistance in the primary circuit of the current transformers.

As in the case of the D.C. system described above, the main current circuits and the volt or shunt circuits are quite distinct, there being no electrical connection between them.

The former are fed off the secondary side of step-down transformers, the voltage being about 20; these transformers are built in halves, and both the primary and secondary windings may be connected in series or parallel, as shown in the diagram. It is thus possible to utilise them with a large range of alternator volts.

The volt circuit is not connected directly to the alternator, but to the piece of apparatus designated "phase adjuster" in the diagram.

A common method of altering the power factor in A.C. testing circuits is to make use of choking coils, &c., but this method has the great disadvantage that alteration in power factor also produces changes in the volts and amperes.

The "phase adjuster" overcomes this difficulty. The amperes and the volts may be set to any required value, and the power factor can then be adjusted to any value from zero to unity, lagging or leading, without disturbing the current or volt adjustments.

The main portion consists of the armature of a 10-H.P. 400-volt four-pole D.C. motor, complete with windings, commutator and shaft, &c., the armature being of the toothed-core type, with former-wound coils. In order to form a closed magnetic circuit, thus avoiding excessive magnetic leakage, and at the same time keeping down the magnetising current, sheet-iron stampings, in the form of rings, separated by paper in the usual way, were pressed over the armature, making good magnetic contact with the iron core stampings.

The armature being four-pole, the three-phase mains are led in at six points as shown.

The armature and outer ring are fixed inside a specially constructed switchboard, the commutator and shaft end only being visible. A loose sleeve is fitted on the shaft, and on the sleeve, two arms are clamped. These arms are provided with wooden handles and support insulated spindles carrying brush-holders. The brushes are made of copper, and are filed to a knife edge, so that they can only touch one commutator segment at a time, and moreover, cannot cause a short when moving from segment to segment.

By loosening the clamping screws, the brushes may be moved relatively to each other, and the voltage between them varied by steps equal to the volts between two adjacent segments of the commutator. When the handles are clamped to the sleeve, the combination as a whole may be moved round the commutator, thus producing any desired phase difference between the "pressure circuit" fed from the phase shifter, and the "current circuit" connected to the L.T. side of the step-down transformers.

The diagram (fig. 2) shows the complete connections of the phase shifter to a meter testing circuit.

Standard instruments should only be used by the senior testers for the purpose of checking suitable sub-standards. For D.C. work, the most suitable sub-standards are direct-reading instruments of the "moving-coil type," provided that well-made instruments are used.

For A.C. work, "hot wire" instruments form most convenient sub-standards, and can be checked against the D.C. standards.

The most convenient standards for the checking of current, volt, and watt measuring sub-standards are undoubtedly the potentiometer, and Kelvin balances.

A most reliable method of measuring A.C. volts accurately, is by means of a sensitive multi-range electrostatic voltmeter, the *modus operandi* being as follows:—The deflection on the voltmeter when connected to the A.C. circuit is noted, the instrument is then switched over to a D.C. supply, and the previously noted deflection reproduced by suitable adjustment of the pressure, which can at the same time be measured on the potentiometer. This method eliminates all scale and zero errors of the voltmeter.

All instruments should, as far as possible, be permanently joined up and ready for immediate use on the particular work for which they are primarily intended.

For cable testing, with the aid of Price's guard wire, the author has found it possible to absolutely eliminate any leakage deflection on an unshunted galvanometer, having a constant of 1,000,000 megohms when connected to a 400-volt battery, and using a test lead over 100 yards long with damp ends. This severe test was only made as an experiment; in practice it is advantageous to have the guard wire as well insulated as conveniently possible, in order to avoid excessive discharges from the batteries.

If a secondary battery is installed for the meter and general testing work, there is no reason why it should not be used for insulation testing, &c., provided that a few necessary precautionary measures are adopted. The accumulators have a very low internal resistance; it is, therefore, necessary to put in series with them a fairly big resistance, to prevent accidental burning of contacts, &c.

For insulation testing, one end of the battery will require to be earthed, and it is, therefore, advisable to arrange the circuits in such a way that when the battery is in use for testing purposes it cannot be connected to the charging circuit, which probably forms a portion of an already earthed network.

Banks of lamps are used for the artificial battery resistance, and also act as a potential regulating resistance, thus enabling various intermediate voltages to be obtained.

Money is well spent on photometric apparatus.

Probably the most convenient standard, both for reliability and durability, is the "Harcourt" 10-C.P. pentane lamp.

Corrections must be made for the effect of barometric or hygrometric conditions on the candle-power of the lamp, by means of the formula established by Mr. Paterson.

Ordinary incandescent lamps will be found very useful sub-standards, and should preferably be of the metallic-filament type. Before calibration they should, if new, be run for at least 200 hours, and the volts should be rather below the normal when making the final adjustment of candle-power.

Such a calibrated sub-standard will retain a definite candle-power for two or three hours, provided that the current is main-

tained constant; this should not be done by adjusting the volts at its terminals, but by actually measuring the current taken on the potentiometer, and regulating it with a resistance having a fine range of adjustment. By this means all errors due to drop of volts in contacts are eliminated.

After a set of comparisons with other lamps has been made, the sub-standard should again be checked against the pentane lamp.

For comparing lights of different colours, the author prefers the Simmance-Abady patent flicker photometer. For the ordinary work of comparing incandescent lamps with a standard incandescent lamp, excellent results may be obtained with a grease spot photometer, probably with less fatigue to the eyes and in less time than would be possible with the flicker type.

A standard gas meter and reliable pressure gauge are absolutely essential if gas lamps are to be tested; and this should certainly be done if possible, as nearly all the existing figures for gas illumination have emanated from gas authorities, and without going so far as to doubt their accuracy, it must certainly be admitted that the source of information is a strongly biased one.

Apparatus designed for mains testing should be as simple to operate and as direct reading as possible, since the local and climatic conditions usually associated with this class of work are not such as conduce to expert manipulation of apparatus, or the rapid working out of involved mathematical formulæ.

The periodical testing of the distributing system under working conditions has been very much neglected in the past, but engineers are now beginning to realise the advantages of being able to feel the pulse of the network. The best known methods are the "Raphael," the "Russell" and the "Frisch."

The "Russell" test is a very convenient one to carry out, and has been reduced to its simplest form in the extremely ingenious instrument known as the "Groves" network tester. It has been found best to use a multi-range ammeter and voltmeter for this test, since it then becomes practically possible to obtain open scale reading under almost all conditions.

Fig. 3 shows a simple arrangement which has proved itself to be most convenient for the purpose of portability.

The four-way ammeter switch gives ranges of 5, 10 and 50 amperes, also a by-pass position. The voltmeter has 75, 150, 300 and 450-volt ranges. Should the outer faults be nearly balanced, an artificial fault of 10, 20, 30 or 40 ohms can be thrown on either side of the system by means of the two-way knife switch.

A portable testing plant is very convenient for carrying out the B. of T. "double working pressure test" on sections of H.T. feeders before they are joined through to the generating station; or for testing cables which cannot be linked through to the station. In Manchester all the necessary machinery and apparatus is installed in a specially constructed van, which may be drawn by two horses.

A 10-KW. 500-volt single-phase alternator is direct-coupled to a 16-B.H.P. D.C. motor. The alternator is connected to the primary of a "Cowan-Still" patent regulating transformer, and the secondary of this transformer is connected to the primaries of three oil-insulated and cooled step-up transformers, giving voltages up to to 30,000.

The D.C. supply for the motors is usually obtained from the nearest point on the L.T. network.

Owing to the small size of the plant, and the fairly high magnetic leakage in the transformers, it is necessary to exercise great care when raising the pressure on a cable, as the conditions are very favourable for producing resonance effects; and, moreover, the comparatively heavy leading current causes a considerable rise in the terminal P.D. of the transformers and alternator. It has

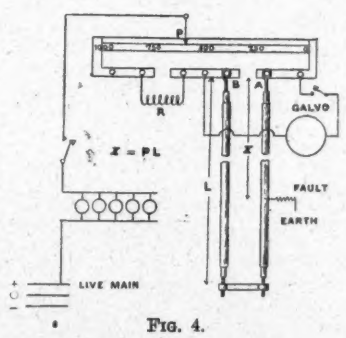


FIG. 4.

frequently been found that an adjustment of the transformers, &c., which would give a pressure of about 10,000 volts on open circuit, would easily give from 15,000 to 20,000 volts on a long length of cable. When conducting tests of this description, it is therefore essential to have a voltmeter connected directly to the cable, instead of estimating the pressure from the readings of a voltmeter in the primary circuit of the transformers.

For fault localising the following is a simple, but little used, method for making a slide wire bridge practically direct reading, and at the same time utilising the full length of the slide wire (fig. 4). The faulty cable is connected to the terminal A, and the loop or return cable to B.

The other gap of the bridge is closed by a resistance R, exactly equal to the resistance of the slide wire, and preferably constructed of the same size and class of wire. If an ordinary millimetre scale is used and the full length of 1,000 millimetres is taken to represent unity, smaller readings representing proportionate decimal fractions; then if L = length of cable (single), and p = reading on scale, $x = p$ L.

It will be seen that the available length of scale is exactly doubled, since if the extra resistance were not used, no reading beyond 50 centimetres could be obtained. Should the cables forming the loop not be of the same size, then the usual calculations would have to be made, and consequently, as with other direct reading localisers, there would not be much gain beyond the opening out of the scale.

The work allocated to the motor test room is of far more importance that would appear at first sight.

About 50 per cent. of the motors delivered require adjustment in some form or other, and it is frequently necessary to reject machines altogether.

It is advisable to make rough efficiency tests on all sample machines, and occasionally on an odd one or two out of a large delivery; but, as a rule, tests of this description should be omitted from the ordinary routine work, as the actual efficiencies of the machines generally agree very closely with the makers' guaranteed figures.

The following characteristics of a D.C. motor are the ones which mostly concern the actual users:—Speed variation (with varying load); ditto (with varying temperature); temperature rise; sparkless commutation under all conditions of load and temperature.

All this information is obtained from, say, a six hours' run at full load, combined with short tests at varying loads, both before and after the six hours' heat run.

The motors are most conveniently loaded by belt connecting them to dynamos, the output of the latter feeding back to the supply.

Motor starters require to be tested for correct coil resistance, adjustment of overload and no-volt release coils, &c., also for heating when starting up a motor under the conditions of the specification or guaranteed time limit rating.

DISCUSSION.

The discussion was opened by MR. GEORGE WILKINSON, who remarked that the paper would be of great value for reference to those regularly engaged in testing work, &c. He was quite opposed to the idea of co-operative testing stations, as testing departments should be conveniently situated in the areas they served, otherwise carriage and such like expenses would be largely increased. He further thought that routine testing would be impossible, and this was the most important point against the scheme. At Harrogate their testing apparatus cost some £250 (this not including armature winding or instrument-making plant).

MR. HAYDN HARRISON advised that portable photometers should be used with inclined screens, not horizontal ones. He thought that more errors crept into photometry through using the Harcourt standard than was generally imagined, and suggested that the National Physical Laboratory's electric sub-standard should be used.

MR. A. J. CRIDGE drew attention to a phase-shifting device which he had devised for work in the Sheffield Electricity Department's test room, and MR. H. D. BURNETT pointed out that, in short-period tests, the error in starting watches often caused discrepancies in results, as regards meters; he also mentioned the necessity of dial testing.

MR. R. HORNBY agreed with a previous speaker as to the advisability of carrying out routine tests in a particular district, but he thought it would be a good plan to link up the private testing laboratories with some central institution, so that standard instruments could be tested there.

A simple phase shifter could be made for 30s., which was much less than the price of the various devices on the market.

MR. RATCLIFF decided to reply in the *Proceedings*.

TRADE WITH NEWFOUNDLAND.

THE Board of Trade have issued a report on the conditions and prospects of British trade in Newfoundland, by Mr. Richard Grigg, the special commissioner, who recently paid a visit to the colony for the purpose of investigating the situation of affairs. There is scarcely anything of electrical interest in the report, a fact which is probably explained by the circumstance that the population, including Labrador, only comprises 230,000 people, a large proportion of whom are engaged in the fishing industry, which is the principal trade.

St. John's, the capital of Newfoundland, is provided with an electric street railway and a reasonable equipment of telegraphs is in existence. The telegraphs, railways and certain other undertakings were transferred by the Government in 1898 to Sir Robert Reid, the well-known contractor, but in 1901 the telegraphic system was handed back to the Government. The Grand Falls, which are situated about 200 miles from St. John's, give a head of water which appears likely to yield abundant power for all practical needs of the wood pulp and paper industry. The three countries which participate principally in the foreign trade of the colony are the United Kingdom, Canada and the United States. As far as the total imports are concerned, British trade gradually declined year by year down to 1905-6, and the Canadian proportion to the total has also slightly decreased, whereas that of the United States has steadily increased, although a considerable share

of the latter comprises raw materials in which Great Britain cannot compete. In the case of manufactured articles only, the British share in the four years ended with 1905-6 averaged 45·1 per cent., that of Canada was 21·3 per cent., and that of the United States 26·6 per cent.

Dealing with the question of competition with the United Kingdom, the report states that severe rivalry in regard to machinery and steel is experienced from Canada or foreign countries, which in some cases have become predominant, the United Kingdom being badly beaten by the United States and Canada in cranes and mining machinery. The causes of the success of Canadian or foreign competition are to be found in the geographical situation of Newfoundland in relation to Canada and the United States, their more numerous manufacturers' commercial travellers, and their Government commercial agents; willingness to take any amount of trouble in offering or showing goods, and in meeting buyers' wishes in regard to the nature of the goods, delivery or terms of purchase. The result has been, to some extent, the creation of the impression amongst buyers that British merchants and manufacturers are inclined to be indifferent to the Newfoundland market, regarding it as almost insignificant in comparison with their total trade. Other reasons are afforded by competitors adapting their goods to the requirements of the colony; the superiority of Canadian and foreign goods over British manufactures, which is alleged in a number of cases in respect of quality and workmanship, together with cheapness, as, for instance, in steel axles, car wheels, steel rails, &c.; and the quotation of goods c.i.f. in dollars and cents, and the use of identical weights and measures as in the colony.

The report proceeds to suggest that British firms should seek to increase their trade by the promotion and encouragement of facilities for quick and cheap transportation and communication; that manufacturers should study Newfoundland conditions for themselves, and not depend so much as in the past upon merchants and agents; that they should cater for the demand and produce the goods required in the colony; that they must adopt the American standards, particularly for iron and steel, which have been introduced in the colony. It is also suggested that more business might be done with detailed catalogues and advertising, and that the British Government should appoint a national trade representative to render similar services as the United States consuls.

An appendix to the report gives details of the Newfoundland Customs tariff. It appears from the list that a duty of 35 per cent. *ad valorem* is levied on telephone and telegraph instruments, electric and galvanic batteries, lamps and lanterns; 40 per cent. on india-rubber manufactures, 30 per cent. on iron or steel rails, railway coaches and tramcars and their component parts, and automobiles; 35 per cent. on steam boilers, machinery and parts, electric light machinery and electrical material of every description, including carbons, electric meters and electrical apparatus; 25 per cent. on gas engines. Among the articles exempt from duty are those imported by or for the use of the government departments or of the municipal council, and also machinery of all kinds to be employed in the actual breaking of coal or ore underground or in an open pit, as, for instance, coal-cutters, pumping engines, compressors, special machinery, &c.

PARLIAMENTARY.

Central Ireland Electric Power Bill.

THIS Bill came before the Earl of Donoughmore's Committee of the House of Lords last week.

Mr. Freeman, K.C., appeared for the promoters, and Sir Ralph Littler represented the Dublin and Alliance Gas Consumers' Co., petitioners against the Bill.

MR. FREEMAN explained that under the Bill it was proposed to construct a generating station at Robertstown. The site would be near the Timaho bog, and the promoters by an arrangement with the owners had acquired 500 acres of the bog, which had a depth of 25 ft. They estimated that on a 30 per cent. load factor with 15,000 H.P. that would meet the requirements for the next 50 years. The electrical energy would be generated by means of gas produced from the peat.

MR. J. STURGEON, engineer to the promoters, gave evidence in support of counsel's opening statement.

Witnesses were called to prove that the proposed capital would be ample, and that there would be no difficulty in raising the £200,000 proposed to be found.

MR. LAWRENCE WICKHAM, chairman of the Blackrock U.D.C., supported the scheme. In his opinion, the opportunity of obtaining electricity in bulk would be of great advantage. The Council had powers under an Act of 1901 to establish generating works, but had not carried them out, owing to the great cost that would be entailed. If the Bill passed, the Council had entered into an agreement with the company to obtain enough current to carry out the powers under its provisional order of distribution.

MR. HERON, town clerk of Blackrock, gave similar evidence.

SIR RALPH LITTLER, K.C., called, on behalf of the Dublin and Alliance Gas Consumers' Co., MR. W. F. COTTON, secretary and manager of the company. He said that they were opposed to the Bill on the ground that it would be unfair competition. If the scheme of the Council in taking a supply from the promoters should fail, the Gas Co., as ratepayers, would have to pay their share, whilst suffering at the same time from the Electricity Co.'s competition.

MR. S. SELLON said that, in his opinion, the proposals of the promoters were absolutely impossible.

SIR RALPH LITTLER then addressed the Committee in opposition to the scheme, and MR. FREEMAN having replied,

The CHAIRMAN said that the Committee had decided to allow the Bill to proceed.

Metropolitan Electric Tramways Bill.

THIS Bill came before the Unopposed Committee of the House of Commons (Mr. Emmott presiding) on Thursday, and was ordered to proceed. The measure authorises the construction of a small extension of the line between Harrow Road and the Paddington line, so as to connect the tramways inside and outside the Metropolitan area. There is a proviso in the Bill that the construction of this tramway shall not proceed without the consent of the L.C.C., and if that body comes for power to construct, the company shall not oppose it.

A clause was inserted by the Committee, providing that the police authority can make representations to the Board of Trade on the condition of the tramway track. A clause was also inserted providing that, in calculating charges in respect of traffic conveyed partly on the proposed tramway and partly on any other part of the company's undertaking with which it is connected, the proposed tramway and the existing undertaking shall be deemed to be one undertaking. The Committee further reported that, while of opinion that as a matter of general public convenience it might be desirable, as suggested in the report, that the Commissioner of Police should have the power to affix notices to tramway standards subject to proper protection being afforded to the owners of the tramway, yet they considered that, as the tramway proposed to be authorised by the Bill was only about a mile in length, it was desirable to secure to the tramway undertaking better protection than was afforded in the clause submitted on behalf of the Secretary of State, and they allowed the powers sought without inserting the clause.

London United Tramways Bill.

THIS Bill, which has already passed the House of Commons, came before the Select Committee of the House of Lords, presided over by Lord Donoughmore, on Tuesday. Mr. Balfour Browne, K.C., appeared for the promoters, and the opponents were the Middlesex and Surrey County Councils.

MR. BROWNE explained that the object of the Bill was to enable the company to link up their systems on the north and south sides of the Thames by the construction of a tramway over King Edward VII Bridge at Kew, and the only question was as to what the company should pay to the County Councils for the right. The House of Commons Committee inserted a clause to the effect that the company should pay the County Councils £1,000 a year by way of rent. He did not think this was right, but still he could not get out of it. The County Councils, however, now wanted the company to agree to lay the tramway either on the conduit or the surface-contact system. This the company objected to, and they further objected to regulations regarding the traffic on the bridge, which the authorities wanted to make.

Several witnesses gave formal evidence on behalf of the promoters.

MR. CUTHBERT BREBATON was called on behalf of the petitioners, and said that the overhead system would interfere with the amenities of the neighbourhood. The conduit system could be used on the bridge.

The Committee passed the preamble of the Bill, but left it to the Board of Trade to decide what system should be used. The County Councils would be able to go before the Board on the matter.

Great Northern, Piccadilly and Brompton Railway Bill.—Mr. Emmott's Committee of the House of Commons, on Tuesday, passed the preamble of the above Bill, to which there was no opposition. Sir George Gibb, general manager of the Underground Electric Railways, explained that the real object of the rearrangement of capital was that the railway was leased to the Underground Railways Co., who were to pay a rent, under a perpetual lease, equal to 4 per cent. on the total share and loan capital of the company. The anticipations of those who made the agreement had not been realised, and it was practically intended to cancel the agreement.

Leith Burgh Tramways.—Mr. Emmott's Committee of the House of Commons has passed the preamble of the above Bill, which authorises the Corporation of Leith to construct and work tramways beyond the limits in respect of which they are the local authority, under the Tramways Act, 1870, viz., in the City and Royal Burgh of Edinburgh. The tramways are to be in connection with other tramways to be constructed by the Corporation under the powers of the Bill, and the Committee is of opinion that having regard to special local circumstances, such construction and working ought to be constructed subject to a clause agreed upon between the two Corporations. The amount proposed to be borrowed for the construction of tramways and street works is £50,000, and the Committee has fixed 30 years as the period for the repayment of the loan.

Ravensthorpe Urban District Council Bill.—The Police and Sanitary Committee of the House of Commons has passed the Ravensthorpe Urban District Council Bill, part II of which deals with electricity. Clause 10, which provided for the purchase of electricity in bulk; Clause 11, giving power to transfer the electric lighting order to the Electrical Distribution of Yorkshire, Ltd.; Clause 13, dealing with the supply of electricity where the consumer has a separate supply; Clause 14, providing for electric lighting consumers giving notice to the Council before removing; and Clause 16, to allow a discount on electric lighting and power accounts, were all withdrawn. Clause 12, giving the Council power to supply electrical fittings, was agreed to.

Burnley Corporation Bill.—The Select Committee of the House of Lords presided over by Lord Donoughmore has passed the preamble of the above Bill, which provides for the construction of new tramways, at an estimated cost of £70,000. Power is also given to supply electric fittings.

LEGAL.

Underground Electric Railways Co.

On Thursday, the 16th inst., in the Chancery Division of the High Court, Mr. Justice Swinfen-Eady granted a petition by the Underground Electric Railways Co. of London, Ltd., for the confirmation of its scheme for the conversion of its profit-sharing security notes into new obligations.

The petition was opposed by the dissentient note-holders.

Mr. Younger, K.C., said the scheme involved very large figures and very important interests. The company was formed in 1902 with a share capital of £5,000,000, of which £4,800,000 was paid. It had constructed the Baker Street and Waterloo Railway tube, the Great Northern, Piccadilly and Brompton tube, and the Charing Cross, Euston and Hampstead tube, and had electrified the Metropolitan District Railway. For the purpose of supplying electrical power to these four companies, it had erected a large power station at Lot's Road, Chelsea, at a cost of nearly £1,400,000. The company also had a considerable interest in the London United Tramways. In addition to its share capital, the company had issued £7,000,000 profit-sharing secured notes, £775,000 power-house debentures, and £300,000 secured temporary loans (outstanding). On December 1st last, interest on the profit-sharing notes of £7,000,000 amounting to £173,591 was not paid, and the interest of £175,000 due on June 1st being also unpaid, the principal fell due, and unless this scheme of readjustment went through, the company could not pay the money. The scheme, which was duly approved at the meetings (only holders of £28,000 out of £7,000,000 being against it), authorised the company to create (1) £1,000,000 5 per cent. prior lien bonds to bearer, maturing in November, 1920, and, with the consent of the holders of 4½ per cent. bonds, a further issue of £250,000; (2) £3,000,000 4½ per cent. bonds to bearer, maturing in 1933; (3) £5,200,000 6 per cent. income bonds to bearer, maturing in January, 1948.

All these bonds carry additional interest equal to the amount of the British income-tax.

The terms of the exchange are that the company shall allot to each holder of notes fully-paid 4½ per cent. bonds of a capital amount equal to 40 per cent. of the capital amount of his notes; and fully-paid income bonds of a capital amount equal to 70 per cent. of the capital amount of his notes. Two holders respectively of £26,000 and £500 profit-sharing securities now opposed the scheme on the ground that it was framed in the interests of the shareholders and not of the note-holders.

Mr. Levett, K.C., stated that the scheme was not fair and reasonable; that it did not disclose to the Court the state of the company, and in particular the loan of a million pounds, nor what security for nearly three-quarters of a million, now held for temporary loan notes, was being given to the company, and that it did not, with the exception of providing for the redemption of the temporary loans, compel the company to apply the money in the way in which the circular said it would be applied.

His Lordship said the duty of the Court was to consider whether the scheme was a reasonable compromise or arrangement, and one which could by reasonable people conversant with the subject, be regarded as beneficial to those on both sides who were making it. The points raised by the opponents of the scheme did not go to the substance of it or prevent its being a fair and reasonable one. His view was that taken as a whole it was fair and reasonable, and probably the best that could be devised in the interests of all parties concerned. He therefore affirmed the scheme.

Escott *v.* Minehead Electrical Supply Co., Ltd.

This case came before his Honour Judge Beresford at the last Taunton County Court, in which Clara Escott, widow, claimed from the defendants £156 under the Workmen's Compensation Act, in respect of her husband, James Escott, who died through carbon monoxide poisoning while in the respondents' employ. The case was reported in our issue of June 26th.

Mr. Clarke, on Tuesday last week, said that he had consulted a specialist, and admitted that carbon monoxide did not come under the definition, although he was advised that it ought to.

Mr. E. H. C. Wetherred then asked for an award in favour of the respondents, which his Honour made, with costs.

National Telephone Co. *v.* Gouraud.

At the Brighton County Court on Friday last, Colonel Edward Gouraud, of Marine Parade, was sued on an adjourned default summons by the National Telephone Co., Ltd., to recover £5 5s., proportion of telephone rentals, Post Office fees, and removal charges. Defendant counterclaimed for £10,000 on the following grounds: (*a*) neglect of duty; (*b*) breach of contract; (*c*) pecuniary loss; (*d*) injury to health; (*e*) prolonging an already long and critical illness; (*f*) increasing expense of doctors; (*g*) unwarrantable and illegal disconnection of exchange service; and (*h*) making statements prejudicial to the credit and honour of the defendant.

According to the *Sussex Daily News*, when the case was called, his Honour Judge Scully said he had been told that the counterclaim was withdrawn.

Evidence was given as to the contracts and order of removal.

Colonel Gouraud announced that he was going to deal with the counterclaim in the High Court, and he denied the amount due.

Frederick Hooper, exchange inspector, described defendant as a very worrying subscriber. Many a hundred times he had inspected Colonel Gouraud's line, and in nine cases out of ten found it all right. In the other cases the faults were not serious.

Colonel Gouraud: You found me one of the most troublesome subscribers?—Yes.

I used very strong language on some occasions?—Yes; you always complained and said we were a lot of thick-heads and did not know our work.

Mr. Moorhouse, Brighton manager of the company, said that, generally speaking, Colonel Gouraud had a good telephone service. On one occasion witness visited the Colonel, who made no specific complaints, but generally abused the directors. He talked of a portrait hanging upside down in the room, and also spoke about fighting duels.

In the witness box Colonel Gouraud admitted the contract.

His Honour gave a verdict for the plaintiffs for the amount claimed, as Colonel Gouraud had not established that the service was practically useless during the period.

Cross & Cross *v.* E. Mosley & Son.

In the King's Bench Division on Tuesday, Mr. Justice Walton gave judgment in the case of Cross & Cross, constructional engineers, Walsall, against Emmanuel Mosley & Son, contractors, of Derby. The case was before his Lordship the other day, and it will be remembered that plaintiffs claimed damages for breach of a contract to supply certain iron and steel work for the electric power station erected by the Corporation of Derby, the contractors for which were defendants. Defendants declared that the work was not supplied by October 31st last, the date specified in the contract, and defendants also raised a counterclaim on the ground that they had to procure the material from another source at greater cost. The plaintiffs replied that the delay in placing the work at Derby was due to the insufficiency of the plans and specifications sent to them by defendants, who denied this.

His Lordship held that the date specified for the completion of the work was not of the essence of the contract, and that consequently defendants had no right to rescind the contract. He therefore found for plaintiffs on the claim for £83 damages and costs. He found for the defendants on the counterclaim, on the ground that plaintiffs did make some unjustifiable delay, which put defendants to some expense. He awarded defendants £16 damages on that issue, and £20 costs.

The Rights of Tramcar Conductors.

At the Brentford County Court on Friday, before his Honour Judge Howland Roberts, Wm. F. Westwood, of the Potteries, Brentford, sued the London United Tramways, Ltd., for £50 damages for assault and personal injuries.

Mr. J. B. Morle was for the plaintiff, and Mr. Pyke-Glasgow for the defendants.

Plaintiff stated that on January 4th he, with a friend, boarded a tramcar in High Street, Brentford. Witness was unable to get a seat inside, and the conductor told him to go outside; he declined, and said that as they were near Kew Bridge people would be getting out and he could then sit down. The conductor pushed him out of the car on to the step, and then, whilst the car was moving, shoved him again, and he fell, injuring his knee.

Corroborative evidence was given for the plaintiff. On behalf of the defendants, it was given in evidence that there was no room in the car, and the by-laws and the police regulations required that there should not be overcrowding. Furthermore, the plaintiff was under the influence of drink. He would not leave the car, swore at the conductor, and struck him in the mouth with a parcel he was carrying. The pushing-off was denied, and it was asserted that whilst on the step plaintiff slipped and fell.

His Honour said that the plaintiff committed a wrong in refusing to leave an overcrowded car, and the conductor was acting in the interests of the company in requesting him to leave. But he went beyond his duty in pushing the plaintiff off the car, and obviously he should have stopped the vehicle and called in the aid of the police to take the plaintiff's name, and stop a breach of the peace. He complained of having been assaulted, and there again it was a matter for the police. There was an ejectment from the car, and more force was used than was necessary. He found for the plaintiff, £12 damages.

NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

Simplex Quick Action Turn Switch.

Messrs. Simplex Conduits, Ltd., of Garrison Lane, Birmingham, are introducing a neat little switch, fig. 1, of low projection, with quick independent action. Fig. 3 shows the inside of the cover and a specially shaped fibre disk, which is actuated by the milled knob on the outside. The fibre disk is so arranged as to work the spring shown in fig. 2 (which is the base of the switch). The centre piece, which holds the spring, revolves and puts the spring in

Fig. 1.

Fig. 2.

Fig. 3.

tension; the latter, however, has no effect until it has passed the centre, when it comes into action immediately, giving a rapid make and break.

The cover is not fixed by screwing on, but by two springs fitting into special notches in the porcelain base; to remove the cover, a small screw-driver is inserted between the base and the cover opposite either rivet head, or a special key is supplied for the purpose.

The E.A.C. Prepayment Meter.

The accompanying illustration represents a new patent prepayment meter on the electrolytic principle, which is being put on the market by The Electrical Apparatus Co., Ltd., of Caxton House, Westminster. The meter consists essentially of a gas voltameter, the glass vessel shown being partly filled with a solution of caustic soda; there are two fixed nickel electrodes

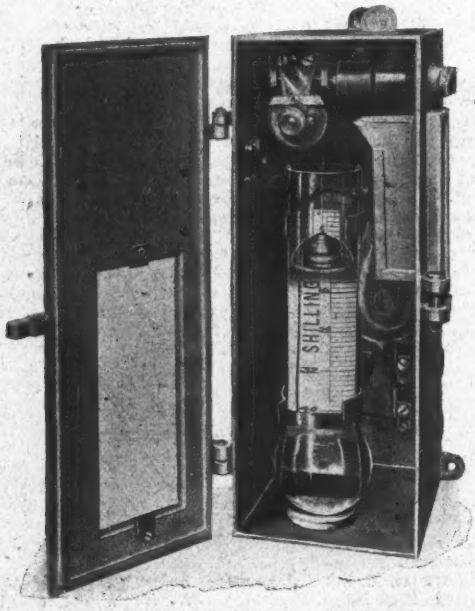


Fig. 4.—E.A.C. Prepayment Meter.

running down inside the glass cell, and a movable one suspended in the centre of the cell by a nickel wire from a drum at the top of the meter. Normally, the current flowing to the installation passes from one of the fixed electrodes to the suspended electrode, electrolysing the liquid and lowering its level in exact ratio with the amount of electricity consumed. When the surface of the solution falls below the suspended electrode, the circuit is interrupted; connection is restored by inserting a shilling through a slot in the top of the case and turning the handle seen on the right-hand side of the meter, thus lowering the electrode into the solution. Several shillings may be inserted if desired, the electrode being lowered to a corresponding extent.

A layer of paraffin oil on the surface of the electrolyte prevents evaporation of the latter; and sparking in the oil at the moment when the electrode ceases to touch the electrolyte is avoided by the following means: the third electrode is connected through a lamp with the suspended electrode, so that when the latter breaks contact the current is not wholly interrupted, but passes through the solution by way of the fixed electrodes, and through the lamp to the installation. The consumer's lamps are thus caused to burn dimly, until he inserts another shilling. The dimming lamp may be left in circuit for any length of time; as the whole of the current always passes through the solution, it is effective in lowering the level of the latter, and is paid for by the next shilling. None of the electrodes are fused into the glass vessel, which is quite plain. A small glass bell is placed over the suspended electrode, so that practically only the gas which is evolved from the surface of the latter rises around it, and there is no risk of ignition at break of contact. The meter is constructed to take about 45s. before it need be refilled, and the operation of refilling, which is done with pure water only, is very simple. The rate of charging is readily changed, by substituting a glass vessel of larger or smaller diameter, at trifling cost. There is nothing to wear out or break down, and no means of tampering with the record.

"Willcox-Ramoneur" Patent Boiler-Tube Cleaner.

A new method of cleaning boiler tubes is being introduced by Messrs. W. H. Willcox & Co., Ltd., of 23, Southwark Street, S.E. The apparatus employed, called the "Ramoneur," consists of a nozzle through which live steam is blown, inducing a jet of air; the dry-heated air and steam are directed spirally through the smoke-tube to be cleaned, and sweep out the soot, without moistening it and so forming cakes and incrustation. The operation is very rapid; it is stated that a nest of 70 tubes can be efficiently

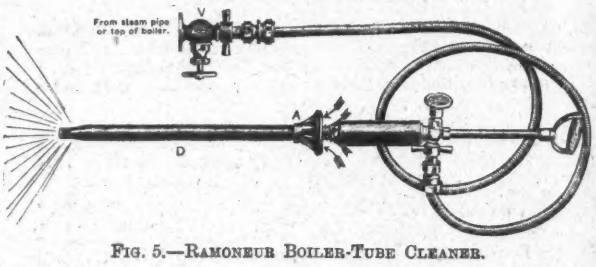


Fig. 5.—Ramoneur Boiler-Tube Cleaner.

cleaned in four minutes, and the work can be done while the boiler is in use. Water-tubes can also be cleaned with this apparatus, and the accompanying illustration, fig. 5, shows the pattern employed for this purpose. The cone-shaped head marked A is the nozzle through which the steam and air are blown, and the tubular end piece D enables the blast to be directed upon the outside of the tubes. The nozzles can be made interchangeable, so that where both types of boiler are in use, one apparatus only is required.

CORRESPONDENCE.

Letters received by us after 5 P.M. on Tuesday cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.

Accumulators for Peak Loads.

It is with much reluctance that I trespass upon the hospitality of your columns, but it is to correct a mistake of some considerable importance, and one that tells very adversely against batteries, and this must be my excuse.

The comment of practically everyone who has hitherto criticised my paper has been that the use of cells is doomed to discontinuance directly any station acquires a decent load factor.

In the case of the large majority of our municipal systems it would be most unsafe to predict that the load factor will exceed 30 per cent. in the course of the next 10 years. If, then, it can be shown that, as far as *fixed* charges are concerned, the battery can compete with steam additions, even where there is a good load factor, the only question remaining is whether, in the matter of *running* expenses, this saving is not wiped out by the inefficient battery.

An analysis of the Neptune Bank mid-winter peak for 1903 (see Merz's paper, April, 1904), shows that, by putting in a battery on a three-hour rating, it would be practicable to take up 40 per cent. of the peak. The capital cost would be £15 per KW., and the annual *fixed charges* £2·2 per KW. of maximum demand per annum, as against £4·6 per KW. with reciprocating engines, or, say, £4·2 per KW. with turbines (see fig. 14 of my paper, corrected by adding £0·45 per KW. to the battery curve, as already explained at Nottingham). It may here be remarked that it is the high value of *other* fixed charges than capital costs which tells against steam, as my fig. 11 was intended to illustrate.

The *running* charges will also be less (although the load factor at Neptune Bank must have been quite 30 per cent.),

because the battery enables certain engine and boiler units to be shut down altogether, on account of the all-night load being so much less than the day load.

The diagram given with my paper (fig. 8) shows a net saving of some 4,750 tons of coal per annum for a station which is mostly a lighting station. On a station with a large power load, this would, no doubt, be considerably reduced; but there would certainly still be a saving, even where steam turbines were employed, on account of the reduced number of boilers under commission.

Surely there are many municipal stations that have yet to beat the power load possessed by Neptune Bank in 1903-4, or is "Lightning's" column of load factors not to be trusted?

Is it too much to hope that the above simple example, which anybody can check for himself, will at least cause engineers to consider whether the continuance of the use of batteries does so entirely depend on the obtaining of a power load; and whether the all-night load, and the sizes of steam units employed, do not have something to say in the matter?

A. M. Taylor.

King's Heath,
July 17th, 1908.

Electric Rock Drills.

There appears to be in the mining industry a most important demand for rock drills which is not at present, so far as I am aware, met by any manufacturing firm. Many experiments with rock drills have been made, both driven direct by electricity and through the medium of an electric air compressor, but up to the present with limited success.

I am aware of cases where hundreds of drills are in daily use, and the old methods of hand-operating are still in force, notwithstanding that a cheap and reliable supply of three-phase current at 50 cycles is available and a good drill much desired by the owners.

Through the valuable medium of your columns I shall be pleased to hear from, or be placed in direct communication with, manufacturers of electric rock drills of repute, as the difficulties to be overcome in boring holes 1¼ in. diameter and 4 ft. deep in rock are surely slight compared with other problems which have been successfully grappled with by the electrical industry.

Electric Miner.

Spain, *July 7th*, 1908.

BUSINESS NOTES.

Sports.—The twelfth annual sports of the G.E.C., Salford, took place at Belle Vue Gardens, Manchester, on Saturday last. Unfortunately the weather was against outdoor sport, but the big list of events proved very popular. For the thirteen events there were some 550 entries; prizes to the value of over £50 were offered, these including two silver cups, presented, as usual, by the president, Mr. H. Bevis, for the 220-yd. handicap, and by Mr. H. Hirst for the half-mile handicap.

German Lock-out.—The Vulcan Engine Building Co. recently started a lock-out in order to compel their employés to work 1½ hours overtime—from 5.30 p.m. to 7 p.m. Nearly 8,000 men are affected by the order.

Nernst Lamps.—The prices of Nernst lamps have been reduced since July 15th, and all lamps are now guaranteed by the A.E.G. English Manufacturing Co., Ltd., 4-5, New Compton Street, Charing Cross Road, London, W.C.

Book Notices.—"Standard Handbook for Electrical Engineers." Second edition. New York: McGraw Publishing Co. 1908.

"Radio-Telegraphy." By C. F. Monckton. London: A. Constable and Co. 1908. Price 6s. net.

Sales, &c.—A patented method of using both internal combustion and steam in prime movers is for sale or licence. An electrical company's stock is offered for sale.

Sales of machinery will take place on Tuesday, 28th inst., and on Thursday, 30th inst., in London.

A patent for the electric welding of steel tubes is to be had on licence. See our advertisement pages to-day.

Catalogues and Lists.—MESSRS. FRANCIS BARNETT AND FOSTER, LTD., 66, Moor Street, Birmingham.—List of prices of brass hexagon nuts, sizes from ¼ in. to 1 in.

T. SUGDEN, LTD., 180, Fleet Street, E.C.—Leaflets giving particulars, with illustrations, of Sugden's patent superheaters for Lancashire, Cornish and Dryback boilers, also internally-fired superheaters, Sugden's steel combined stop and isolating valves, and Sugden's reducing valves for varying pressures and conditions.

THE HODDESDON MANUFACTURING CO., Hoddesdon, Herts.—Leaflet relating to their "Revolution" wood split pulley.

HART ACCUMULATOR CO., LTD., Stratford, E.—Illustrated price list of ignition batteries for motor-cars, boats and cycles.

THE BRITISH THOMSON-HOUSTON CO., LTD., Rugby.—Illustrated pamphlet, No. 210, describing their Curtis steam turbines of the horizontal shaft type.

SIMPLEX CONDUITS, LTD., Garrison Lane, Birmingham.—Progress sheet No. 275, illustrating a new type of porcelain interior with split terminals, so that connection can be made without cutting the main wires; also cheap brass brackets.

MESSRS. SIEMENS BROS. & CO., LTD., Queen Anne's Chambers, S.W.—Catalogue No. 508, of testing instruments and accessories, a department which the company is developing. The catalogue, which supersedes No. 38, describes moving-coil instruments of various types, portable ammeter and shunt, improved Siemens Universal galvanometer, direct-reading wattmeter for unbalanced three-phase circuits, current transformers, mirror galvanometers, ohmmeters, potentiometers, portable bridges and testing sets.

Trade Announcements.—MESSRS. C. J. THURSFIELD AND CO. have removed their London showrooms from 21, Berners Street, W., to more convenient and extensive premises at 28, Berners Street, W., where they will show a new series of examples of special fittings to harmonise with the panelled room, and certain decorations for the seventeenth and eighteenth centuries. Their new telephone number is 6,792 P.O. Central.

MESSRS. SOUPER & CALLAGHAN, engineers and agents, of 46, Grosvenor Chambers, Deansgate, Manchester, have formed a partnership for the purpose of carrying on business as buying and selling agents for all classes of machinery and engineering materials and supplies.

MESSRS. ELECTROMOTORS, LTD., Openshaw, Manchester, notify that their works and offices will be closed from August 1st to August 10th for the annual holiday. Estimating and urgent correspondence will be attended to by a small staff.

THE LANCASHIRE DYNAMO AND MOTOR CO., LTD., of Trafford Park, Manchester, inform us that their works will be closed from 12 noon on Saturday, August 8th, until 9 a.m. on Monday, August 17th, 1908. No goods will be received between these dates, but a small staff will be in attendance to deal with urgent matters.

ARC LAMPS, LTD., St. Albans.—The works will be closed from July 31st to August 9th, 1908, inclusive.

MESSRS. MORRIS-HAWKINS, LTD., have removed their London offices to Hornsby House, 75B, Queen Victoria Street, E.C., and will be glad to receive trade catalogues of manufactures allied to the electrical industry. The company is in no way connected with the Morris Aiming Tube and Ammunition Co.

The offices of the *Engineering Times* are now at 30 and 31, St. Swithin's Lane, E.C., where all communications should be addressed.

Bankruptcy Proceedings.—A sitting of the London Bankruptcy Court was held last week before Mr. Registrar Brougham for the public examination of J. T. MURRAY, described under a creditor's petition as of Gunterstone Road, West Kensington. The statement of affairs showed liabilities £3,212, against assets £73, apart from bad book debts £30,250. During the last five years the debtor has been engaged amongst other business in the formation of the Scutari Tramways in Asia Minor. The debtor attributes his failure to lock-up of money in connection with the tramway scheme in Asia Minor; to inability to obtain moneys due to him, and to law costs. Mr. G. W. Chapman, Official Receiver, reported that the first meeting of creditors stood adjourned to enable the debtor to make arrangements with a view to discharging his liabilities. All parties consenting, the public examination was postponed until October 23rd next.

ALFRED WILLIAM BENNETT, 43, Elford Grove, Leeds, lately carrying on business under the style of "Bennett & Co.," electrical engineers, appeared at the County Court House, Leeds, on Tuesday, for his public examination. The liabilities expected to rank for dividend were £1,124 13s. 4d., and assets nil. Debtor stated that in 1892 he made a deed of assignment, and a dividend of 3s. 7½d. in the £ was paid on claims for over £1,400. He was one of the trustees under his mother's will, and, with the consent of the other two trustees, he sold the property at different times, realising £1,300. Questioned as to the disposal of that money, debtor admitted that about £700 was taken by him for use in his own business. In October last debtor made arrangements to borrow £250 at £6 per cent. interest per annum, but only received £131 10s. The examination was adjourned until August 11th, the debtor being ordered to amend his statement of affairs by the inclusion of the £700 in connection with the trust.

Contracts Awarded.—The following contracts have been awarded to MESSRS. J. R. NORRIS & CO., Oldham:—Empire Theatre, Bolton, lighting; Royton Ring Mill, Oldham, lighting and plant; Ensor Mill, Rochdale, lighting and plant.

Amendment of Patent Specification.—Leave is sought to amend Patent No. 16,269 of 1906 for "Improvements relating to electric induction furnaces." See our advertisement pages for particulars.

Dissolutions, Liquidations, &c.—Graham, Morton, Ltd.—The liquidator, Mr. R. Hilditch, has announced that after the liquidators of the old company have paid the debts incurred by it, there will not be quite sufficient available to discharge the amount owing to the debenture-holders of this company. There will, therefore, be no dividend for the creditors of this company.

Thomas Parker, Ltd., Wolverhampton.—Notice is given that a meeting of the creditors of the above-named company will be held at the office of the company, Wednesfield Road, Wolverhampton, on Thursday, the 30th inst., at 12.30 p.m. This is a formal meeting. Since the date of the circular of July 14th, 1908, the chairman of the company, Mr. C. T. Mander, has been appointed receiver and manager for the debenture-holders, and he is carrying on the business until the necessary formalities are completed and the new company formed.

Meldrum Bros., Ltd.—The petition for winding up this company, is to be heard at the Royal Courts of Justice, on July 28th.

Walsall Electrical Co., Ltd., and Reduced.—The petition for reduction of capital will also be heard as above.

Electromobile Hiring Co., Ltd.—This company is winding up voluntarily, owing to amalgamation with the Electromobile Co., Ltd.; Mr. G. Cockerton, 7, Hertford Street, Mayfair, is the liquidator.

Lancashire Electric Supply Co., Ltd.—Creditors are required to send particulars of debts, &c., to Mr. John Collier, the liquidator, 4, Chapel Walks, Manchester, by August 7th.

South-Western Electrical Co., Ltd.—A meeting to hear an account of the winding-up, &c., will be held at the office of Messrs. Elles, Salaman & Co., Oxford Court, Cannon Street, E.C., on August 21st.

Conduits and Fittings, Ltd.—A meeting to hear an account of the winding up, will be held on August 17th, at the office of the liquidator, Mr. H. Douglas Brown, 12, Southwark Street, London.

Annual Outings.—On Saturday, 11th inst., the second annual outing of the West Ham Corporation's electricity staff took place under ideal weather conditions. The party went in brakes to Broxbourne, Herts. After dinner a series of sports were held. In the tug-of-war the generating station team showed their pulling powers to be of no mean order.

The Aberdeen Corporation tramway employés held their annual picnic last week, when Mr. R. Stuart Pilcher, manager, presented the prizes to the winners of the sports.

The employés of the Chloride Electric Storage Co., Ltd., had their annual picnic to the Dukeries on Saturday last. The weather being fine, a very large percentage of the men turned up. On arrival at Worksop, breakfast was partaken of at the Greyhound Hotel, after which a drive of some 15 miles was taken through Welbeck, Elwinstowe, Thoresby and Clumber, returning to Worksop for dinner. The whole arrangements were admirably carried out, and the outing proved very enjoyable to all.

On Saturday last, Messrs. E. P. Allam & Co., of Red Lion Street, E.C., held their annual works outing at Rye House, the excursion being attended by all the employés, staff and agents. A cricket match was played, and notwithstanding the somewhat inclement weather a very enjoyable day was spent. The toast to the firm, proposed by Mr. W. Crisp, was responded to by Mr. E. P. Allam, who made an interesting speech, explaining in detail the success of the different departments of the firm. The Works Department was proposed by Mr. E. Ralph, and the Contract Department by Mr. A. R. Lovell.

LIGHTING and POWER NOTES.

Aberdare.—The U.D.C. has approved of the E.L. scheme prepared by Mr. Stephen Sellon, and has decided to have plans and estimates prepared with a view of applying for a loan to carry out the work.

Aldershot.—The U.D.C. has decided to supply energy for arc lamps outside business premises at 3d. per unit, provided the premises are lighted internally by E.L., and that each consumer provides a separate circuit and pays 2s. per quarter meter rent.

Aylesbury.—The U.D.C. has received notification that an E.L. prov. order is being applied for by a private London company.

The Chesham E.L. Co. has informed the D.C. that it desires to extend its area of supply into the Council's district. The Council has asked for fuller particulars.

Berkhamsted.—The U.D.C. has received notification that a prov. order for E.L. is being applied for by the United E.L. and Power Co. Provided the interests of the Council are adequately safeguarded, the application will not be opposed.

Beverley.—A private company has informed the T.C. that it is applying for a prov. order for E.L.

Broughty Ferry.—The electricity department has ended the year with a credit balance of £220, and it has been agreed to reduce the charge to 3d. per unit for power, and 5½d. per unit for lighting purposes, a reduction of 1d. and ½d. respectively.

Chester.—On the 15th inst., Mr. H. R. Hooper, Inspector of the L.G.B., held an inquiry into an application of the Corporation to borrow £30,500 in connection with its electric lighting undertaking. This sum includes £3,000 for buildings, £20,700 for plant, £4,300 for mains and services and public lamps, and £1,000 for purchase of motors. A further application is for £1,500 in connection with the wiring of consumers' premises. The Inspector said he thought it was proposed to put in a very large machine considering the returns of the power consumed. He also criticised the scheme for the free wiring of premises, and said that corporations all over the country were giving it up. He expressed doubt that the Board would sanction that part of the scheme with reference to lighting, as the Council had nothing immediate in view. It was stated that the profits of the undertaking were £17,773 from the commencement.

Continental Notes.—Germany.—The municipal authorities of Eschweiler have decided on the establishment of a central electric lighting station in the town.

Denny.—In connection with the electric lighting, the T.C. has decided to adopt a system with overhead lines from the proposed sub-station. The system will be three-phase four-wire, having voltages of 230 between each phase and neutral, and 400 volts between phases. The B. of T. has sanctioned the scheme. The estimated cost, allowing for contingencies, is approximately £2,000.

Dunfermline.—Sir Alex. B. W. Kennedy has been asked to adjust the detailed terms of the agreement arrived at with Mr. Balfour, of the Fife Electric Power Co. The town clerk has received a letter intimating that the Fife Electric Power Co. intends this year to apply for a prov. order under the Electric Lighting Acts for the burgh of Dunfermline. The letter explains that the intimation is intended merely to preserve the company's position, and not to interfere with the course of the present negotiations.

Harrogate.—A L.G.B. inquiry was held on July 17th into the application of the T.C. for a loan of £16,500 for E.L. purposes. The inspector (Mr. H. R. Hooper) elicited the fact that a large sum had reference to excess expenditure, and he eventually amended the application to £4,600, which was reduced by credit sums to £2,888.

Hastings.—The T.C. on July 17th decided to convert 480 gas lamps for electric lighting, and to apply to the L.G.B. for a loan of £1,683 for this purpose.

Hindley (Lancs.).—The B. of T. has deferred for a year the question of revoking the U.D.C.'s E.L. Order.

Holsworthy.—Messrs. Christy Bros., of London, have informed the U.D.C. that they intend applying to the B. of T. for a prov. order for E.L.

Horsham.—At this week's Council meeting the accounts for the year ending March 31st were presented. The gross profit was £1,881, as against £1,710 for the previous year. The net loss for the year was £148, as against £174 for the previous year.

Llandudno.—The T.C. has decided to reduce the flat rate for electricity from 5½d. to 5d. per unit; the maximum demand rate from 7d. and 2½d. to 7d. and 2d. per unit, and the contract rate for consumers of 15,000 units, from 4½d. to 4d. per unit.

A return issued last week, gives the total income for the year for the electricity undertaking as £8,828, made up as follows: Private lighting, £7,577; public lighting, £433; traction purposes, £796; sundries, £22. The net profit for the year, after providing a sum of £3,031 for interest and sinking fund charges, was £1,480, of which £458 was allocated to reserve fund, £600 to relief of rates, and £422 was carried forward. The total number of units generated was 735,581.

London.—The Highways Committee recommends that tenders should be invited for the lighting of Westminster Bridge by electricity. At present the bridge is illuminated partly by gas and partly by electric light, at a total annual cost of £512. The substitution of arc lamps for the existing gas lamps, which the Committee thinks would be a great improvement, would reduce the annual cost to £436.

Shoreditch.—A conference was held in the Town Hall last week of representatives of Borough Councils owning electricity undertakings. The object of the gathering was to consider the London and District Electric Supply Bill and the London Electric Supply Bill, as amended in the House of Lords, and the decision of the conference was that both Bills should be opposed by petition.

Fulham.—The Guardians are proposing to extend their electric lighting plant, and the borough electrical engineer was instructed recently to inquire whether it would not be to the interests of the ratepayers for the whole supply to be taken by the Guardians from the Council's mains. The Guardians furnished full information, and the borough electrical engineer has prepared a report which shows, assuming his figures can be substantiated, that the Guardians would effect a saving by taking energy from the Council. A copy of the report is to be forwarded to the Guardians.

L.C.C.—At the meeting of the L.C.C. on Tuesday, it was decided to lend £14,599 to the Poplar B.C. for improvements and additions to the refuse destructor by the installation of power-raising plant for supplying steam to the electricity works. The plant is to be erected and maintained by the Horsfall Co. free of cost for a period of two years. It was also resolved to advance £2,520 to the Stepney B.C. for the provision of meters, the loan being repayable in 10 years on the instalment system.

Malton.—The U.D.C. has accepted the tender of the Northern Electricity Supply Co. to light the town for three years at £400 per annum.

Malvern.—The U.D.C. has decided to extend the mains to Malvern Wells, at a cost of between £600 and £800, the canvass having warranted the extension.

Norwich.—At a recent meeting of the T.C., the Electricity Committee reported that the units sold in 1907-8 amounted to 3,661,522, as compared with 2,839,130 in 1906-7. The sales for private lighting in 1907-8 were 1,694,223 units, as compared with 1,481,339 units; for public lighting, 41,867 units, as compared with 40,918 units; and for motors, 1,925,432 units, as compared with 1,316,873 units. The revenue for 1907-8 showed an increase of £3,336, while the expenditure was larger by £3,329. The balance carried to net revenue account for 1907-8 was £16,744. An outlay of £1,194 had been made for new motors during the past year at the charge of revenue. The cost of the coal consumed in 1907-8 was £6,603, as compared with £5,027. The charge for interest and sinking fund showed an increase for the year of £1,680. After making provision for all charges, there was a net profit for the past year of £3,105, increased to £3,300 by £195 brought forward from 1906-7. Out of this balance the Committee allocated £3,200 to depreciation, leaving a balance of £100 to be carried forward to the credit of 1908-9.

Radstock.—The U.D.C. on Friday received notice that the Radstock and District Electric Supply Co. intended applying for a prov. order for E.L.

Southport.—The annual report of the electrical engineer shows that during the past year the net profit of the electricity department has been £3,834. The gross profit was £15,568, on a total revenue of £25,404. During the year the capital account was increased by £5,755, of which £5,017 was for extension of mains, 5½ miles of distributing cables and services being laid during the year.

Swanage.—A prov. order for E.L. is being applied for by Messrs. Foote & Milne, Ltd.

Taunton.—The L.G.B. has sanctioned loans as follows:—£290 for excess expenditure and new pump; £520 for mains; £550 for house services; £310 for transformers. These sums amount to a total of £1,670, being £330 less than the total amount originally applied for by the Council. The latter sum was for meters, but, on the Committee ascertaining that only five years would be allowed by the Board for the repayment of the amount, it was decided to provide for the purchase of meters out of revenue.

Truro.—A notification was received last week by the T.C., from a certain company, stating that it intended to apply for a prov. order to supply electricity in the Council's area. Mr. Lodge: How many times have these people notified similarly? The Town Clerk: Ever since I have been town clerk.

Worcester.—In order to encourage the use of electricity the T.C. has decided to supply new consumers with energy for lighting at 1d. per unit up to September 30th, and at 2½d. per unit from October 1st to Christmas. The same terms will be available for existing consumers for additional lights connected during the periods mentioned, including re-connected consumers.

TRAMWAY and RAILWAY NOTES.

Belfast.—The halfpenny fares have proved a ghastly failure in Belfast, there having been a heavy falling off in the number of passengers and fares. The halfpenny fare was introduced chiefly through the agency of four members of the Corporation who made a tour of some English towns. A special meeting of the Corporation will be held at the end of the present week to consider the situation. Mr. Nance, the general manager, who all along opposed the halfpenny fares, will again submit the fares and stages he submitted three years ago, and which he then contended would alone make the tramway system pay. At a meeting of the Tramway and Electrical Committee on the 20th inst. that course was recommended.

Bexley.—It is anticipated that a working agreement will shortly be arrived at between the District Council and the Erith Council for the through-running of the respective tramway systems. The Bexley Council has resolved to accept Erith's offer of 6½d. per car-mile upon a minimum of 68,000 car-miles per annum. It has also been decided to enter into an agreement to lease to the Erith Council the Bexley tramway from a point in the Market Place, Bexley Heath, to Northumberland Heath, on a yearly tenancy, this being, of course, subject to various conditions.

Burnley.—The re-arrangement of the electric tramway service has had a marked effect on the traffic. For four days last week the passengers numbered 166,239, and the receipts were £938, an increase of £83 on the corresponding period of last year.

Darwen.—The revenue account of the Darwen section of tramways, after allowing £900 for depreciation, shows a gross profit of £4,068; there is a net profit of £242. This compares with a gross profit of £4,169, and a net profit of £478 for the previous year. The net loss standing to the debit of the profit and loss account is £1,196. The miles run were 213,699; receipts, 13·6d. per car-mile, compared with 209,936 miles at 14d. per mile in 1906-7.

Haslingden.—At the T.C. meeting, on July 16th, it was reported that the Board of Trade had sanctioned the arrangement by which Accrington will run its cars to the centre of Haslingden at a charge of 7d. per car-mile for cars, current, and conductors, Haslingden finding its inspectors and taking third party risks.

Handsworth.—The District Council is to make an offer to the City of Birmingham Tramways Co. to purchase the cable line along Soho Road from Hockley to New Inns.

Hastings.—The T.C. has agreed that the continued running of Sunday trams should only be sanctioned on the tramway company entering into a binding agreement that, in the event of the Corporation purchasing the concern, the Sunday profits should not be considered.

Liverpool.—On Wednesday the Corporation decided by a large majority to try the experiment of running first-class cars on the route from Garston to the Pier Head, which passes through the better-class suburbs of Liverpool. The fares on these cars are about double the ordinary fares.

London.—The recently electrified Aldgate-Bow service of the L.C.C. tramways has been suspended, apparently on the strength of official reports showing that there had been accidents. Meanwhile, the old horse service has been resumed.

According to a *Daily Telegraph* interview with Mr. Fell, the chief officer of the L.C.C. tramways, the latter is reported to have said that so far as his information went, there had been only two complaints of shocks to pedestrians, and neither case was at all serious, and another London daily hints that the troubles have arisen through the "improvements" carried out by the L.C.C. officials on the original G.B. apparatus.

CITY AND SOUTH LONDON TUBE FIRE.—On Thursday evening last week, about 6 p.m., a fire broke out on the City and South London Tube in the cross-over road on the south side of Moorgate Street Station, resulting in the stoppage of traffic. The fire arose from the fusing of some cables and caused damage to the permanent way, and the burning out of a disused signal box.

As is usual, considerable difficulty was experienced in attacking the fire, which, however, was subdued by 9 p.m., traffic being resumed by mid-day Friday. Col. Yorke and Mr. Trotter have held an official inquiry into the matter, which stands adjourned.

Manchester.—The Corporation tramways during the past year produced a revenue of £769,072, of which £500,022 went in working expenses; £55,000 was allocated to the relief of rates, £87,000 for reserve, renewals and depreciation, and £4,000 for street improvements. Nearly 17 million car-miles were run, against 15½ million in the previous year; passengers carried numbered 151,477,138, against 143,264,501 in the previous year. Since 1901 the tramways have contributed £307,000 in relief of the rates. There was a drop in the receipts per car-mile from 11·02d. to 10·76d., chiefly owing to the inclemency of the weather. The report embracing the above period ended March 31st, 1908, was adopted by the Committee on the 21st inst.

Mitcham.—Efforts are being made to secure an extension of the L.C.C. tramway system in the direction of Mitcham Lane, and the Highways Committee of the L.C.C. has been asked by a mass meeting to provide for the extension in the 1909 County Council arrangements. A landowner in the district has made an offer to the County Council to give £1,000 towards the cost of making the tramway from the Streatham terminus in the High Road to the county boundary in Mitcham Lane, but this offer has not been accepted.

Rawtenstall.—It has been decided by the T.C. to extend the electric tramways from Crawshawbooth to Loveclough, at an estimated cost of £14,500.

It transpires that the cost to the Rawtenstall Corporation of the Rossendale Valley steam tramways undertaking is £21,750, which includes everything with the exception of the length of tramways in the borough of Bacup. The total expenditure to date in connection with the tramways and electricity is £114,389, and Councillor Coupe stated at the meeting of the Town Council on the 16th that £120,000 would cover everything.

Tynemouth.—The T.C. and the tramway company are at loggerheads as to the supply of energy for the tramways. Unless the company agrees to increase its minimum annual payment on the basis of 250 KW. supply, the Council is recommended to limit the supply to the actual rate guaranteed at present, viz., 150 KW.; the company had threatened to hold the T.C. responsible in case of an accident arising from an insufficient supply of energy to the tramways

TELEGRAPH and TELEPHONE NOTES.

Territorial Electrical Engineers. — The London Wireless, Cable and Air Line Telegraph Companies (R.E.), which were officially recognised last week as units of the London "Army Troops," are to go into camp to-morrow for training at Warning Camp, Arundel, till August 8th.

Telephone Rates.—The Committee appointed by the Association of Chambers of Commerce to handle the question of telephone rates has decided to nominate a deputation to meet the Post Office authorities and the National Telephone Co., with a view to obtaining from them statements, figures, and arguments in support of the new measured rate.

London-Paris Telephone.—The trunk telephone rate between Paris and London will shortly be reduced to 4s. 2d., practically half the present charge of 8s. for three minutes.

Before the charge is reduced, the present four cables will be doubled. On an average 240 conversations take place each day between London and Paris, and it is expected that when the rate is reduced, the number will be more than doubled.

Telegraphic Interruptions and Repairs :—

Cables.	Interrupted.	Repaired.
Curacao-Coro Curacao-La Guayra } Closed .. Curacao-Maracaibo	.. .. .. Jan. 12, 1906 ..	..
Tarifa-Tangier	.. Jan. 18, 1904 ..	..
Port Arthur-Chifu (Closed)	.. Mar. 9, 1904 ..	..
Las Palmas—Arrecife	.. May 18, 1908 ..	..
Cayenne-Salinas	.. May 9, 1908 ..	..
Pera-Dardanelles	.. May 20, 1908 ..	..
erra Leone-Accra	.. May 28, 1908 ..	..
Cadiz-Tangier	.. June 3, 1908 ..	..
Kwandang-Menado	.. July 9, 1908 ..	..
Cotonou-Grand Bassam	.. July 20, 1908 ..	..

CONTRACTS OPEN and CLOSED.

OPEN.

Algiers.—August 6th. Contracts are open for three years' supply (65,645 pieces) of injected wooden telegraph poles for the Algerian Telegraph Service. Particulars can be obtained from the Inspector-General, 12, Rue Dumas d'Urberville, Algiers.

Australia.—Adelaide.—August 26th. The Postmaster-General requires tenders for 9 tons hard-drawn copper wire, 200 lb. per mile, specification No. 3; 3,000 copper tapes for 200-lb. wire, and No. 5 insulators, as per specification No. 195, to be packed in bundles of 100 each; 3,000 copper binders for 200-lb. wire and No. 5 insulators, as per specification No. 195, to be packed in bundles of 100 each; and 3,000 No. 5 insulators. Specifications may be inspected at the Electrical Review office.

Adelaide.—September 9th. Tenders are invited by the Deputy Postmaster-General, Adelaide, for the supply of one numbering machine and one machine for stamp perforating. Tenders must be sent in on the proper forms, obtainable at 72, Victoria Street, Westminster, S.W. The machines must be fitted with electric motors.

Brisbane.—August 24th. The Postmaster-General requires tenders for iron, copper and covered wires, as per schedule 55, insulators, as per schedule 54, and ironwork, as per schedule 53.

Belgium.—August 11th. The municipal authorities of Louvain are inviting tenders for the concession for the supply of electrical energy for public and private lighting and power purposes in the town. Full particulars can be obtained from Le Directeur de l'Usine de Paz, while tenders are to be sent to Le Collège des Bourgmestre et Echevins de la Ville de Louvain.

Brussels.—The Société des Chemins de fer Vicinaux, 14, Rue de la Science, requires tenders for the supply and laying of underground cables and return rails on the Namur suburban electric lines. Details are available by application to the Directeur-General at the above address.

Brussels.—July 27th. The Forest-les Bruxelles bourgmestre invites tenders for installations of apparatus, fittings and wiring, &c., for the electric lighting of the Pont-de-Luttre Schools.

Antwerp.—July 27th. Tenders for the electric lighting of the new Rovers lock for the municipality. A deposit of 1,000 francs (about £40) will be required to qualify any tender. Tenders to Monsieur le Bourgmestre de la Ville d'Anvers, Hôtel de Ville, Antwerp. Specification (cahier des charges) obtainable from the Hôtel de Ville (0·50 franc), and a copy may be consulted by British contractors on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall Street, London, E.C.

Belgrade.—July 30th. The Post and Telegraph department requires tenders for iron telephone supports, *i.e.*, 300 for two insulators (long); 300 for two insulators (short); 1,000 for three insulators; 1,500 screws &c.; 2,500 hooks; 150 carriers for lightning conductors, &c. Particulars may be obtained from the accountant branch.

Devonport.—General stores for the Corporation Electricity Department. Borough Electrical Engineer.

Eccles.—July 25th. Electric light installation at the new Clarendon Road Council school, for the Education Committee. Specifications, &c., from Mr. Henry Lord, architect, 42, Deansgate, Manchester.

Eccles.—Steel steam pipes and cast-iron circulating water pipes, &c., for the T.C. Specifications and drawing from the Borough Electrical Engineer, Patricroft.

Finchley.— August 6th. Switchgear for the U.D.C. See "Official Notices" to-day.

France.—Chatellerault.—July 29th. A large supply of cable and electric wire is required by the war department. Particulars may be obtained at the Direction des Forges, 2, Avenue de Sise, Paris.

Paris.—The Under-Secretary for Posts and Telegraphs, 103, Rue de Grenelle, requires tenders for 12 lots of copper and bronze wire by July 31st; for iron and copper brackets, &c., by July 29th; for 14 lots of steel accessories, by July 25th; and for 1,250,000 insulators, by August 1st.

Germany.—The municipal authorities of Belzig (Saxony) are about to invite tenders for the establishment of a central electric lighting station in the town.

July 28th. Regierungs-Baumeister Dechling at Memel will receive tenders for a 3-ton iron crane electrically controlled. Particulars may be obtained at a cost of 2s.

Hull.—July 27th. One 900-kw. d.c. generator and Belliss engine for the Corporation tramway power stations. See "Official Notices" July 17th.

Limerick.—July 24th. Arc lamp poles for the borough electricity department. See "Official Notices" to-day.

London.—Stepney.—July 28th. The Borough Council requires tenders for the erection of a high-pressure electricity generating station at Phyllis Wharf, Harrow Street, Limehouse, Stepney, E. Particulars may be obtained, on the deposit of a £5 note, from Mr. M. W. Jameson, A.M.Inst.C.E., Managerial Offices, Great Alie Street, Whitechapel, E.

Manchester.—Electric wiring of the Electrical Exhibition Buildings. Only contractors who are exhibitors can tender. See "Official Notices" July 10th.

Manchester.—July 28th. The Tramways Committee requires tenders for special trackwork (permanent way). Specifications can be obtained on deposit of £2 2s. with Mr. J. M. M'Elroy, General Manager, Tramways Department, 55, Piccadilly, Manchester.

Norwich.—Sewage screening and electrical lifting gear at Trowse sewage pumping station for the T.C. A. E. Collins, City Engineer, Guildhall, Norwich.

Peru.—The Direction of the "Credito Urbano" of Arequida is about to invite tenders for the conversion of the tramway in the town to electric traction.

Radcliffe.—The Hauxley Parish Council invites provisional offers for providing and establishing 21 electric street lamps with aerial wiring, ready for receiving the current. Apply W. Gibson, Clerk, 94, Queen Street, Amble.

Russia.—September 14th. The Town Clerk of Odessa (Upiawa) will receive tenders for a concession to erect and work a power and lighting supply. A central station of a minimum of 6,000 h.p. is to be erected and equipped.

Sierra Leone.—August 22nd. The Municipal Corporation of Freetown invites tenders for the lighting of the municipal buildings and streets by arc and incandescent lamps. Tenderers to quote price per 1,000 units. The exclusive right to supply electricity for private lighting for a period of at least 30 years will be granted to the successful tenderer. The right to install electric tramways may also be acquired. Tenders to Town Clerk, Freetown. Some further information may be seen at the office of Wilkinson & Broadbent, 4, Queen Street Place, E.C.

Spain.—July 28th. The Spanish Post and Telegraph authorities in Madrid are inviting tenders for the supply of 8,000 metres of telephone cable. Tenders are to be sent to La Direccion General de Correos y Telegrafos, Carretas 10, Madrid, whence particulars may be obtained.

September 25th.—The Spanish Ministry of Public Works is inviting tenders for the concession for the construction and working of an electric tramway in Madrid between La Glorreta de Alonso Martinez and Chamartin de la Rosa.

Stockport.—The Electricity Committee wants offers to purchase two d.c. Parsons turbo-generators. See "Official Notices" to-day.

Wolverhampton.—August 7th. The Borough Council requires tenders for uniform overcoats for tramway employés, according to particulars obtainable from Mr. U. A. Luntley, General Manager, Car Depôt, Cleveland Road.

York.—July 27th. Carbon brushes, carbons, meters, motors, lamps, &c., for the Electricity Committee. See "Official Notices" July 17th.

CLOSED.

Australia.—Adelaide.—Municipal Tramways Trust. Supply of overhead equipment, overhead feeders, telephone system and potential wires. British Insulated and Helsby Cables £25,806.

Tasmania.—Mount Lyell Mining and Refining Co., Ltd. Electric compressor, Thompson & Co., Castlemaine. Three-phase 350-kw. motor, four electric mine pumps, the A.E.G., Berlin.

Bedford.—The T.C. has accepted the tender of Messrs. W. H. Allen, Son & Co., Ltd., Bedford, for repairs to the engine at the electricity works, at £80.

Birkenhead.—The B. of G. has accepted the tender of Messrs. Stafford & Co., 117, Oxton Road, Birkenhead, for the supply and fixing of telephones at the workhouse, at £87 13s.

Fife and Kinross Asylum.—The offers of the following have been accepted on the advice of Prof. Baily for the work connected with the new electrical plant:—

Compton & Co., Glasgow.—Electric machinery, £252 9s.
Green & Son, Wakefield.—Economiser (ironwork only), £104.
D. Houston, Cupar.—Injector piping and valves, and renewal of boiler cover, £53 17s. 3d.

London.—Hackney.—After considering tenders for the supply of lubricating oils to the electricity works, the B.C. has decided that the present arrangement with Belliss & Morcom be continued to March 31st, 1909. The oils at present in use are supplied by Belliss & Morcom and Willcox & Co., and, the E.L. Committee reported at the last meeting of the Council, that they had given every satisfaction.

L.C.C.—The Highways Committee of the L.C.C. has received tenders from Spagnoletti, Ltd., at £636, and from Johnson & Phillips, at £700, for the supply of H. and L.T. switchgear required for the central car repair depôt. The offer of the former company is proposed for acceptance.

The tender of the Falkirk Iron Co., amounting to £910, has been accepted for the supply of cast-iron insulator frames and covers, in substitution for that of S. P. Hutton, who recently withdrew his tender of £713 15s.

Norwich.—The Electricity Committee of the T.C. has accepted the tender of Messrs. Babcock & Wilcox, Ltd., for a boiler, with superheater, mechanical stoker and fine ash elevator, hopper and coal bunkers, at £3,215, and that of Messrs. Green & Sons, Ltd., Wakefield, for an economiser with 160 tubes, at £281.

Radcliffe (Lancs.).—The U.D.C. has accepted the tenders of Messrs. E. Allen & Co., Ltd. (Sheffield), for the supply of six spare sets of points and crossings, and of Messrs. Brundrit and Co. for 100 tons of granite setts, at 23s. 6d. per ton.

Rawtenstall.—The T.C. on the 16th inst. accepted the following tenders in connection with the electrification of the tramways taken over from the Rossendale Valley Tramway Co.:—

W. T. Glover & Co., Manchester.—Cables, £21,920.
Browett, Lindley & Co., Patricroft.—Steam dynamos, £4,689.
British Westinghouse Co.—Transformers, £1,000.
Yates & Thom, Blackburn.—Boilers and condensers, £5,418.
Dryland & Preston, Preston.—Erection of the generating station, £7,503.
W. Underwood & Bros., Dukinfield.—Reconstruction of the permanent way, £89,040.
British Insulated & Helsby Cables, Prescot.—Overhead equipment, £8,853.

Stoke Newington.—The Electricity Committee has received the following tenders for the supply of an engine and dynamo for the new generating station:—

W. H. Allen, Son & Co.		£794
Belliss & Morcom, Ltd.	(provisionally accepted)	770
Browett, Lindley & Co.		759

For the erection of the building itself the Committee has provisionally accepted the tender of J. Grover & Son, at £418, and for the switching apparatus, that of Nalder Bros. & Thompson, Ltd., at £183 10s. For the provision of a booster at the sub-station in Edwards Lane the following tenders were received:—

Thomas Parker, Ltd.		£427
Laurence, Scott & Co.		390
Siemens Bros. Dynamo Works, Ltd.		388
Lancashire Dynamo & Motor Co.	(provisionally accepted)	331
Phœnix Dynamo Manufacturing Co.		246

Taunton.—The T.C. has accepted the tender of Messrs. Geipel & Lange for the supply of carbons, at £2 7s. 4d. per 1,000, and that of Messrs. Newton for a pump and gear, at £28 5s.

Thames Ditton.—The D.C. at its last meeting received tenders for installing an alarm system in connection with the Esher detachment of the local fire brigade. The G.P.O. offered to fix alarms outside Esher Station and in the High Street and to connect up five firemen and the contractor for horses, for £11 15s. per annum under a five years' agreement; Messrs. Stuart & More offered the same facilities for £43 7s. 6d. for purchase and a maintenance charge of £5 per annum, or alternatively that a yearly payment should be made of £13 5s. including maintenance for that period. The third tender was that of Mr. Badois, at £45, with a yearly maintenance charge of £4 for a double-wire system, the others being single-wire. The alternative offer of Messrs. Stuart & More was accepted.

Worksop.—Messrs. Thos. Flamwell & Son, of Worksop, have secured the contract for carrying out a complete electric light installation (80-light dynamo) at the Worksop waterworks.

CONTRACTORS' COLUMN.

[The following information is published in the interests of electrical contractors and others who are seeking for openings for new business. Considerable expense is incurred in the production of this column, and every care is taken to ensure that the information is new and accurate, but it will be understood that in a matter where so many correspondents are engaged, and where the amount of information to be handled is very large, this cannot always be guaranteed. If alleged inaccuracies are reported to the Editors, they will be fully investigated.]

ABERCRAVE (Breconshire).—Residence for R. Davies. C. S. Thomas, architect, Wind Street, Swansea.

ABERDARE.—Additions to Tir-rhos, Llwydcoed. J. Ll. Smith, architect, Aberdare.

ALEXANDRIA, N.B.—New United Free Church for the Bridge Street congregation (£5,000). Rev. W. Hamilton.

ALNWICK.—Proposed alterations at the Town Hall. M. T. Wilson, architect, Alnwick.

ARRAN, N.B.—Church and manse for Brodrick United Free Church.

ASCOT.—Two houses, New Road, for Mr. Newell.

AYLESBURY (Bucks).—Houses, Waddesdon, for Miss A. de Rothschild; Haddenham, for J. Simmonds; Quainton, for T. Grace; Oving, for Mr. Clay.

AYTON.—New Wesleyan Methodist Church.

BANNOCKBURN.—Garden City. R. Traquair, architect, 4, Forres Street, Edinburgh.

BARNES.—Development of Blind Lane Estate. Tyers & Gage, architects, 10, John Street, Adelphi, W.C.

BARROWFORD (near Nelson, Lancs.).—New dye works.

BARROW-ON-TRENT.—Renovation of the church (£1,500). Rev. C. S. Thomas, vicar.

BECKENHAM.—Houses, Westmoreland Road, for P. A. Coad; Cromwell Road, for G. Weaver.

BECKINGTON (Somerset).—Alterations and additions to "Sunnyside," for the Rev. T. H. Langford-Sainsbury. P. B. Rigg, architect, Frome.

BEDFORD.—New Howard Memorial Church. E. H. C. Inskip, architect, 31, Goldington Road, Bedford; Corby & Son, builders, Bedford.

BEDWELLTY (Mon.).—Alterations to the Council School, for the Monmouthshire Education Committee. C. Dauncey, secretary, County Council Offices, Newport, Mon.

BEXHILL.—Motor garage, Terminus Road. Mr. Kennedy, owner. G. E. Maynard, architect.

Dwelling house, Turkey Road. Rev. Allen, owner. J. B. Wall, architect.

BIRTLEY (Co. Durham).—Extensive works at Urpeth Collieries, plant to be worked by electricity, for the Birtley Iron Co.

BOOTLE.—New theatre in Stanley Road. J. H. Havelock Sutton, architect, Liverpool.

BOURNEMOUTH.—Houses and shops, Belle Vue Road, Southborne, for A. Ives.

BRANDON.—Parish Hall in London Road.

BROADSTAIRS.—Houses, Grosvenor Road, J. T. May, builder, 26, Albion Street, Broadstairs; Knight's Avenue, for H. Garnett; additions to the Homes of the Metropolitan Convalescent Institution, for the trustees.

BRENTWOOD (Essex).—New Grammar Schools. Chancellor & Son, architects, Chelmsford.

BRIGG.—New Salvation Army barracks.

BRISTOL.—Additions to factory, Rowley Place, Temple Gate, for Todd & Co. H. Williams, architect, Alliance Chambers, Corn Street, Bristol.

BRITON FERRY.—Rebuilding the "Puddlers' Arms" for E. E. Bevan, Neath. J. C. Rees, architect, Parade Chambers, Neath.

BUDE (Cornwall).—E.L. installation at the Station.

BURNLEY.—New Waterworks. Corporation.

BURSLEM.—Proposed alterations at the Wedgwood Institute. A. R. Wood and Sons, architects, Burslem.

BURTON-ON-TRENT.—Prospective rebuilding of maltings and granaries of R. Peach & Co. (recently destroyed by fire).

BURY.—Municipal Housing Scheme. Municipal Engineer.

CAMBRIDGE.—Houses, Shaftesbury Road, for W. H. Jarrold, 95, Regent Street; Albert Street and Castle Street, for Bennett & Sons, Gwydir Street.

CARDIFF.—Reconstruction of business premises, St. Mary Street, for T. W. Long & Co., gold and silversmiths.

New offices, Mount Stuart Square, for a combination of Colliery Companies.

CARLISLE.—Wesleyan place of worship (£2,000). M. Johnstone, architect, Lowther Street, Carlisle; Wm. Baty, builder, West Walls, Carlisle.

CARMARTHEN.—Work at the Shire Hall (£1,693). B. Howell & Son, Ltd., builders, New Dock, Llanelly.

CARSHALTON.—Houses, Mayfield and Hawthorn Roads, Winderbank & Co.; Hill Road, for the Carshalton District Development Co.; Park Lane, for Mr. Hutchinson.

CEFN-MAWR (Ruabon).—Three houses, shops, and stabling, for Christmas Jones. Geo. M. Tune, architect, Trevor, Carnarvon.

CHELMSFORD.—Pair of houses at Widford, for Sir D. Gooch.

CHERRY HINTON (Cambridge).—Additions to schools for Cambridge C.C. (£1,457). Clarke & Sons, builders, Goddesdone Road, Cambridge.

(*Continued on page* 144.)

EXTRA-HIGH-PRESSURE IRONCLAD SWITCHGEAR.

The extension of networks for electricity supply on a large scale, and the gradual raising of pressures which has become necessary in consequence of the extended scope of power supply, has during recent years brought about an entirely new set of conditions as compared with those contemplated by the composers of the original rules and regulations for electricity supply, which merely differentiated between high and low pressure. Practice has now emerged beyond the 2,000 or 3,000-volt system to ranges of pressure in which 6,000 volts are quite common, while even in English practice double and treble that pressure is being adopted as a working value. This rapid change of conditions has induced the evolution of an entirely new system of design, and the sphere in which this change is most apparent is that of the apparatus designed to control the passage of power into, and from, feeders and distributors.

Among the pioneers in this branch of work, Messrs. A. Reyrolle & Co., Ltd., of Hebburn, have taken a very prominent place, and they have recently put upon the market a line of standard switch units of the ironclad type which may be combined to form panels to meet all the requirements existing on extra-high-pressure networks. The system thus fufils the important requirement of interchangeability, with the advantage that extensions or alterations to similar existing gear can be accomplished at the shortest notice and without any break in uniformity. The gear which is about to be described has been specially developed in conjunction with the Merz-Price system for feeder and transformer protection, although any other system of protection may be used. The two chief points which have been kept in view in the evolution of the mechanical construction of this switchgear have been freedom from life and fire risks, and reliability of action. The essential details which go to make up the former of these requirements are: that accidental contact with metal whilst this is alive must be impossible on the part of the operator; the insulation must be built to withstand any excessive pressure that is liable to be impressed upon it, even under abnormal conditions in the working of the system; the design should not allow dust, dirt, moisture or vermin to diminish the insulation; care must be taken to reduce fire risk to a minimum; there should be a minimum amount of cleaning necessary in order to maintain the gear in good condition, and parts requiring inspection and cleaning must be readily and absolutely detached from the gear to enable such operations to be carried out with safety.

As regards reliability of action, it is necessary that the sectional areas of conductors must be such as to carry without deterioration the maximum overload to which they are liable; moving parts, such as switch mechanisms, must be situated where they can be observed; any chances of switches sticking must be reduced to a minimum, and the construction must be mechanically strong in order to stand rough usage and accidental impact. Moreover, in order to avoid trouble on the remaining parts of the supply system, some form of automatic protection must be included in the switchgear, which will isolate the faulty sections without interference with healthy portions, and the switches must be capable of breaking, without disturbance to other parts, on the maximum power which may instantaneously pass through the switch when acting under the worst fault conditions. In order to secure a commercial type of switch which can be sold at a reasonable figure, it is necessary to combine with the above requirements, the simplest possible construction consistent with economy in operation and maintenance costs.

In the switchgear under consideration, the above points have been met by building up the entire apparatus on the solid system, and making it completely ironclad; the solid nature of the insulation renders it impervious to moisture, whilst the ironclad construction eliminates all possible danger of accidental contact with live conductors. Competent authorities upon inspection of the gear have stated that it marks an entirely new era in the construction of electrical switchgear, and the reliability of the apparatus is best demonstrated by the fact that within the last three years over 200 panels, ranging from 1,000 to 3,000 KW. capacity, have been constructed to the orders of various supply companies and installed in many cases in important power stations where a very large capacity of plant is running behind the switchgear, precluding any assistance to the breaking of fault loads by a lowering of pressure. As an example, it may be mentioned that some of the 6,000-volt switchgear is installed at the Carville power station at Wallsend, with from 20,000 to 30,000 KW. capacity of plant running behind it. Moreover, although many of the 6,000-volt and 12,000-volt panels have been standing in damp colliery sub-stations for the past three years, where the buildings and switchgear are often covered with moisture, there has been no indication whatever of any insulation faults or electrical breakdown.

Our illustrations show in detail the appearance of typical panels, both in the open and closed (ironclad) conditions, and it may be interesting to describe their construction in some detail. Referring to the first type, the panel illustrated in fig. 2, we have a gear designed to convey current from an incoming lead-covered cable to the bus-bars of a sub-station. The cable enters from the floor and passes upwards through a split dividing box, which is shown separately on the floor in front of the gear. The cable sheath is connected to the metal of this box by means of a wiped joint, giving absolute watertightness, and at the point of junction a high conductivity ring is provided for attaching an earth connection. The current then passes upwards through the current transformer in each phase to an insulated copper tongue contained in a horizontal porcelain jar, this being the lower orifice shown on each phase in the illustration of the switchgear open. When the switch is closed the current passes through contacts which firmly grip the tongues to the oil-break switch itself, which is supported at the front of the gear on a carriage, from which depends an oil bath containing the arc-breaking contacts. The course of the current is then through the switch contacts to the top contacts of the jars, shown at the back of the gear, and then upwards to a compound-filled uniting box for the phases.

It will be seen that so far as the circuit runs are concerned these divide up into three main sections: First, the run from the dividing box (filled solid with compound) through the lower iron pipe to the tongue pieces (this pipe being filled with compound), again from the tongue pieces through the oil-break switch, giving a liquid but perfectly secure means of insulation, and, finally, back through the upper tongue pieces in an ironclad solid-filled system. There is, therefore, no possible chance of insulation breaking down, even under the heaviest strains and high engine room temperatures, while the entire framework and covering are continuously metallic and efficiently earthed. When the switch is in commission, the live contacts and the insulators are, therefore, completely enclosed and protected by cast-iron hoods, so that it is an impossibility for anyone to make accidental contact with a live conductor. The switch carriage, which is shown at the front of the gear, cannot be withdrawn without first tripping the oil switch, nor can it be placed in commission with the oil switch closed. The arrangements for this provision will be described later. Moreover, on withdrawing the switch carriage, a pair of cast-iron doors automatically come forward and close over the face of the chambers in which the live contacts are situated, and the reverse motion automatically folds them up and carries them into special housing spaces. In order to make security more secure, the doors can be padlocked so that access to the live conductors, under any condition, is impossible. It will be seen that this is a complete "separate unit" panel for a straight through connection.

Passing now to the second type of panel, which is constructed for use in situations where a considerable amount of regulation, and, therefore, a large number of measuring instruments is necessary, thus entailing the attendance of switchboard operators, the same general type of panel is adopted with a modification of the position of

the switch handle. The panel is so designed that it may be placed at the back of a brick wall, the handle gear and instruments being mounted on, and operated from, the front of the wall. As will be seen from our illustration, fig. 3, this method offers a convenient means for mounting the extra instruments that are necessary in central station working, and offers a valuable arrangement for use in power stations and rotary sub-stations. Fig. 4 shows the portion of the gear which is placed behind the wall. Particular attention must be drawn in this illustration to the arrangement for mounting the pressure transformer necessary for synchronising operations and the recording of voltage. This is placed below the switchgear in a rather deeper oil tank than is necessary for the panel gear above described, high-pressure leads being taken from two of the phases through the winding of the transformer, and the secondary being tapped and threaded through a hole (which also forms one of the supports for carrying the transformer), and thence through a flexible connection running through the lever clamp to the top of the switch carriage, and thence through metallic tubing to the front of the brick wall where the instruments are situated. The transformer is protected on each pole by a high-pressure fuse, immersed in oil, the position of which is indicated by the ghost hand appearing on our view. It will be seen that with this arrangement the transformer is completely isolated from the high-tension side by withdrawing the switch carriage, thus eliminating the danger of removing high-tension fuses whilst alive, the whole arrangement being a most efficient and compact one. In order to illustrate the arrangement which can be made where lead-covered cables are not used, this view shows separate cables passing upwards through porcelain insulators by means of taped joints to the current transformers, the path of the current being thereafter as described above. The 'bus-bars are supported directly from the tongue contacts in the top row of jars, and have a clear space round them and inside the ironclad construction, which is then filled up solid with bitumen.

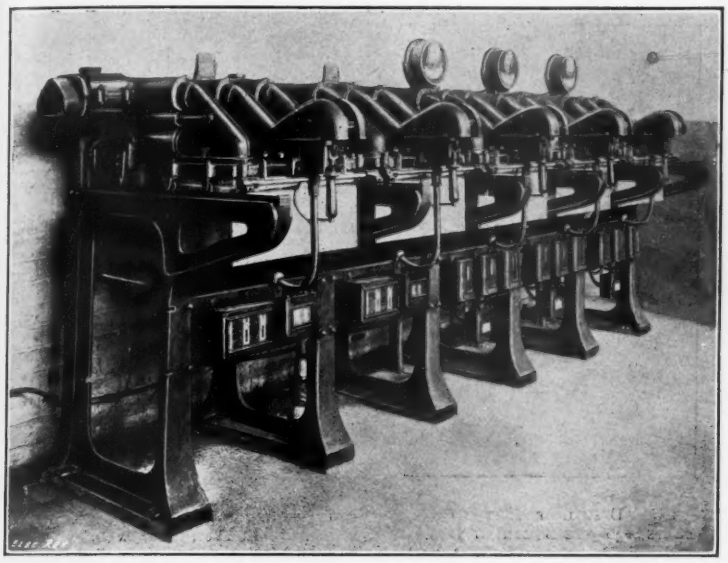


Fig. 1.—Extra-High-Pressure Switchgear at the Walker Sub-station of the Newcastle-upon-Tyne Electric Supply Co., Ltd.

The third type of panel which serves to illustrate this gear is a wattmeter panel, which is suitable for the summation of energy passing through a sub-station and for similar purposes. In this panel, fig. 6, we have two sets of 'bus-bars, an upper and lower tier. The power first passes from the lower set through the device which includes the current transformers and performs the function of isolating switches mounted on a carriage, as described above, to the upper set of bars. The carriage supports, in place of the oil break switch above described, an oil tank for the reception of a three-phase pressure transformer, complete with fuses fixed in the manner above described, the three-phase transformers being necessary in order to give accurate wattmeter readings on unbalanced loads. When forming part of a switchgear the incoming feeders connect to one line of 'bus-bars and the metered panels to the other line, so that all power to be metered passes through the wattmeter transformer device. Any panels whose power is not to be metered connect to the first line of 'bus-bars. The secondary circuit from the pressure transformers passes by means of plug sockets to iron tubing led to a separate meter panel, which is shown at the side of the gear in the illustration.

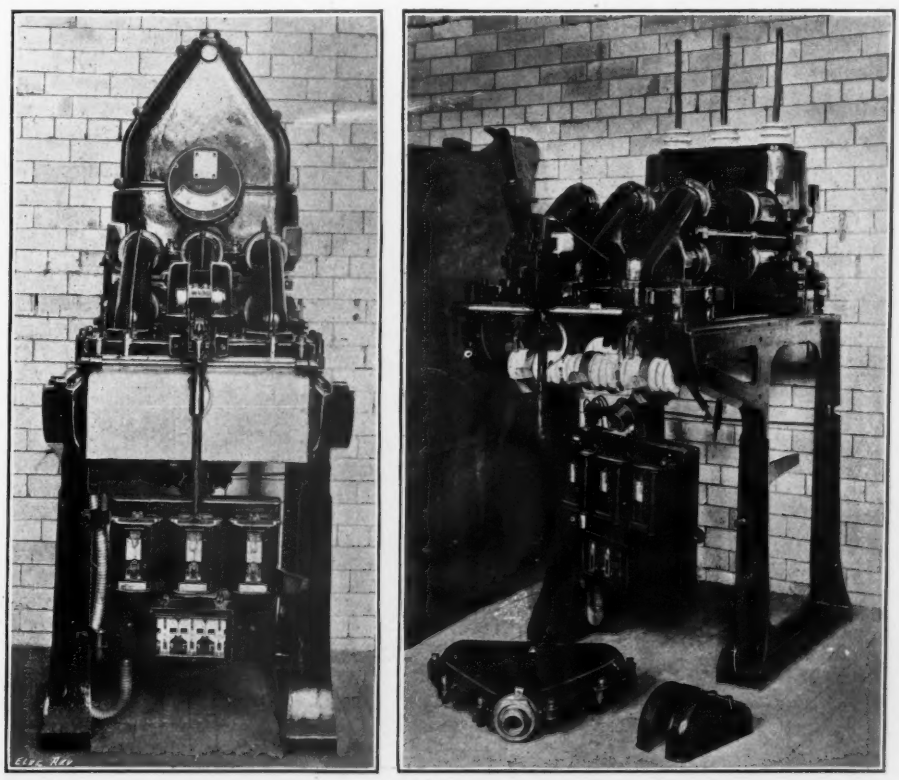


Fig. 2.—Extra-High-Pressure Switchgear, Closed and Open.

This panel, though placed flat against the wall, is hinged so that it can be swung out, enabling inspection and alteration of connections at the back of the meters to be made, a most important point in sub-station work. The B. of T. rule is that 3 ft. must be allowed behind any ordinary switchboard having back connections, but in the arrangement described, the meter board can be mounted in such a position that the attendant can examine the connections while standing in precisely the same position as he would occupy when withdrawing or putting into commission the isolating arrangement. In order to secure freedom from interference by unauthorised persons, a bar can be placed across the front of the carriage, and padlocked, thus preventing any movement of the gear.

The capacity of extra-high-pressure apparatus is determined mainly, not by its normal load, but by the power it is required to interrupt under faulty conditions. It is, therefore, inadvisable to construct any smaller size of panel for low current-carrying capacities than for the largest which may be negotiated in practice, and the size of the gear has been standardised in accordance with the severest conditions of breakdown that could be obtained in stations of large capacity. The overall dimensions of the extra-high-tension gear thus obtained are as follows: From centre to centre of adjacent panels, 2 ft. 3 in.; height, in the power house and rotary sub-station type, about 3 ft.; in the feeder-to-transformer panel type, an additional 2 ft. is necessary to provide for the uniting boxes for the cable shown at the top of the gear; the overall distance from front to back when the gear is in commission is about 3 ft. 6 in.; while another 3 ft. 6 in. is required in the front of the gear for the operation of the carriage. It will be readily seen that these dimensions, which are adhered to for small stations, but which will not be exceeded in the largest gear designed up to a capacity of 2,500 KW., are remarkably compact. As it is necessary to provide somewhat extensive insulating arrangements for pressures such as 12,000 volts, the insulators of gear for that working pressure are made slightly longer than those for 6,000 volts. The general standardisation of parts is carried to such perfection that it is possible to turn a feeder panel into a wattmeter panel, or a static sub-station equipment into a rotary sub-station gear by a simple exchange of parts, so that an engineer can entirely remodel his system at a trifling cost.

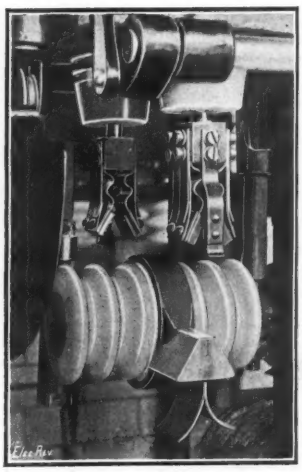


FIG. 5.—DETAIL OF SWITCH CONTACTS AND ARC-BREAKING TIPS.

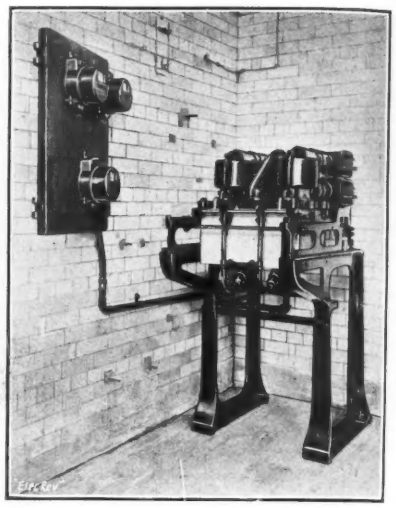
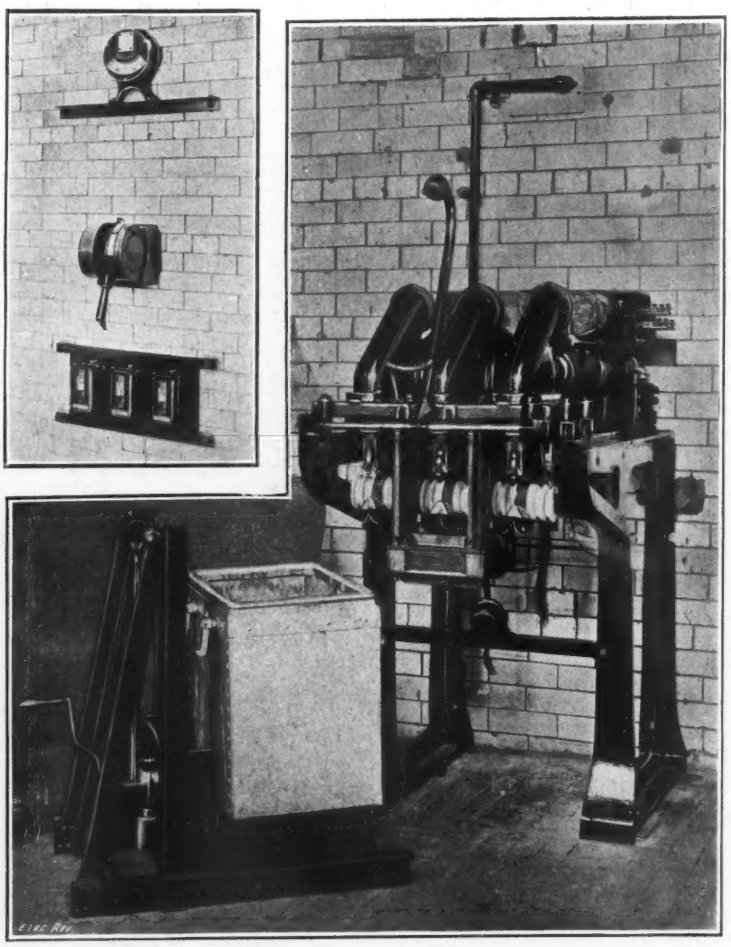


FIG. 6.—WATTMETER PANEL AND SWINGING INSTRUMENT BOARD.



FIGS. 3 AND 4.—FRONT AND BACK VIEWS OF SWITCHGEAR OPERATED THROUGH WALL, SHOWING TRANSFORMER AND TANK CARRIAGE.

The general framework of the oil switch is mounted on rollers which travel on steel rails mounted on the panel, and the switch-handle mechanism is of the free-handle type, thus enabling the gear to be tripped out in the event of a fault existing on a circuit when a switch is being operated. The tripping device (fig. 7) is operated either by a separate battery or current from the secondary of a transformer, and is of the electro-magnet armature hammer type. On the passage of current round the magnet coils, the armature is attracted with considerable force towards the poles, and in its passage strikes against the detent, which keeps the locking catch of the switch in position. This flies over and allows the switch contacts to fall under their own weight. The mechanical operation of the switch is accomplished by means of the small bell crank lever, which is seen near the pivot of the switch handle. When the latter is in a vertical or closed position, a slight movement forward and upwards is sufficient to make the bell crank lever engage with the tripping device, throwing the switch immediately out of contact. The mechanical connection between the free rotating arm of the switch mechanism and the part of the gear inside the oil chamber is made by means of wire rope, which when the switch is closed occupies a line very closely

adjacent to the centre of movement of the rotating part of the switch mechanism, thus reducing to a minimum the chance of accidental turning of the gear round its centre due to vibration. The turning moment due to the tension on the wire rope is, however, just sufficient to pull the rotating part of the gear over when the locking catch is released, and a very quick and rapid opening of the circuit is thereby is released, quite independently of any auxiliary impetus such as is found on some other types of oil-break switches; as, for example, the coiling of springs round the vertical rods of the moving elements. Indeed, the downward travel is so rapid that special means are necessary to soften the blow when the moving element reaches the lower limit of its path, and for this purpose two curved swinging strips are

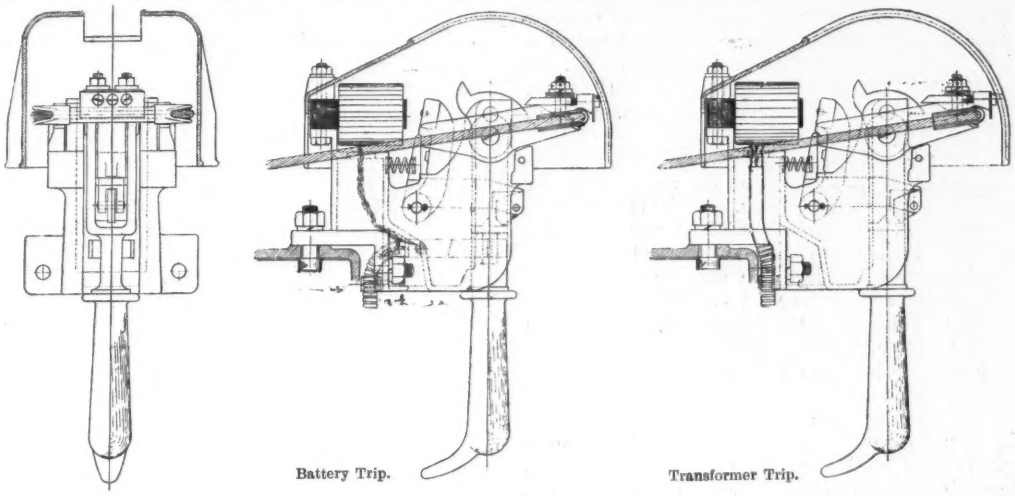


FIG. 7.—DETAILS OF MECHANISM OF SWITCH.

obtained. On glancing at the detailed photograph of the actual switch contacts in the oil bath (fig. 5), it will be seen that these are formed of copper wedges, which, on the switch being closed, are forced into tight contact with spring fingers in parallel, each having its separate tension spring. Easily renewable sparking contacts are also provided on the fixed and movable elements. The angle of the contact wedge hinged to the bottom of each contact of the moving element, which, upon passing through the oil in their downward travel, are forced out by the oil pressure against them, and virtually form a species of parachute, retarding the fall of the gear. The advantage of this is that a minimum resistance to the closing movement of the switch prior to the actual contact between fixed and moving elements is

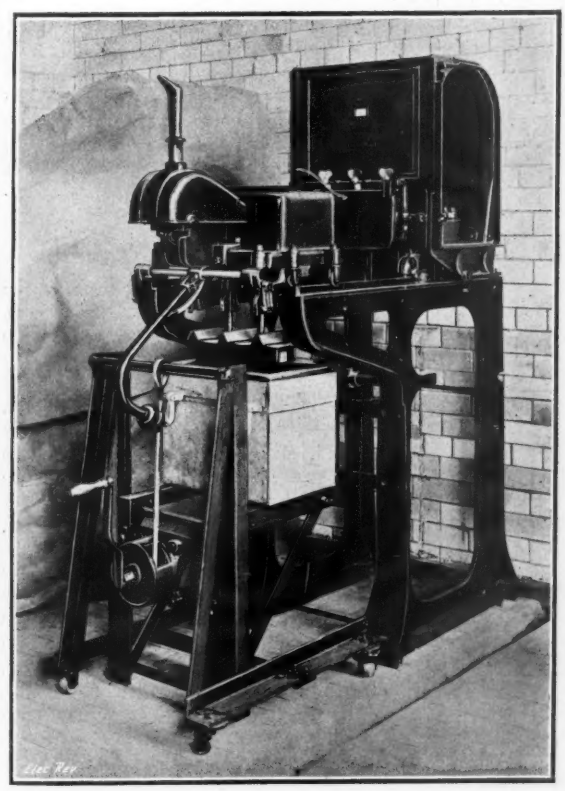


FIG. 8.—400-AMPERE LOW-PRESSURE PANEL, OPEN, SHOWING DOOR OVER LIVE CONTACTS.

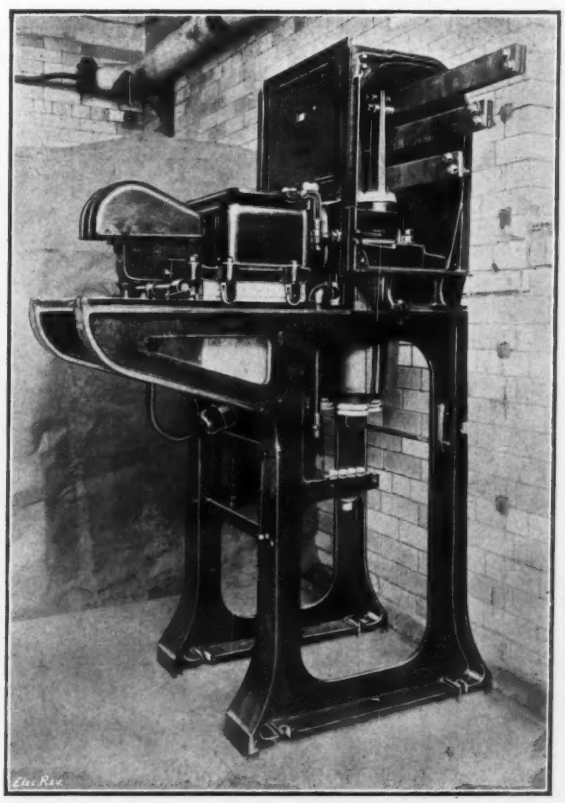


FIG. 9.—1,200-AMPERE LOW-PRESSURE PANEL, SWITCH CLOSED.

is considerably more obtuse than that commonly adopted for such sliding contacts, and the effect of this is to produce a considerable pressure in a downward direction on the moving element, due to the pressure of the springs on the contact. This pressure, together with the weight of the gear, is sufficient to give rapid travel downwards when the switch obtained, and it is therefore easy to parallel quickly and accurately without any calculation as to the amount of strength necessary to force the gear along its path. Moreover, the parachute pieces, in their travel downwards, churn the oil in the tank and prevent the formation of any strips of decomposed carbon particles along the path of the arc,

thus making rupture of the arc certain and rapid. It will be seen that the design of the oil switch throughout is extremely liberal so far as mechanical strength is concerned, and owing to there being no other moving element than a lever pivoted on a pin, the automatic break is extremely rapid and certain in action. An interesting point in connection with the free-handle arrangement is that, whereas the normal position of the handle, as placed by the operator when the switch is open, is vertically upwards, and when the circuit is closed is necessarily vertically downwards, its position, should the circuit have been opened by the relay, is at an angle of about 30° from the vertical line, and it is, therefore, possible for the attendant to tell by a single glance along his line of panels which of the relays has operated.

Mention has been made above of the arrangement for preventing misuse of the apparatus. This may now be described more in detail. In the front of the gear is a curved iron handle terminating in a central pin contact. This handle combines the functions of a metallic tube to carry the secondary circuits from the plug socket below the front of the frame to the top of the switchgear, a mechanical handle wherewith to move the carriage into and out of position, and a striker which can release the locking arrangement and trip the switch. The second of these functions can be described as follows :—At each side of the rails on the main framework on which the carriage rollers run, is a rack system with which engages a reversible pawl fixed to each side of the carriage. When the latter is at its furthest outward position it is detained by a stop on the frame. From this point it can be pushed inward until the contacts are nearly in touch at the back of the frame. Further progress is, however, impossible with a direct push, owing to the interlocking mechanism. It thus becomes necessary to operate the curved handle as a lever, inching the carriage forward by means of the rack and pawl arrangement ; it would be impossible to do this with the switch handle in a vertically downward position, as the curved lever would strike the handle and trip the mechanism. Thus automatic provision is made against putting the carriage into commission with the switch closed. When the carriage is right home, the pin socket connection at the bottom of the curved handle is put into place by a half turn, connecting up the secondary low-pressure trip coil circuits above described. It will at once be seen that it is equally impossible to withdraw the switch carriage from the back contacts without first tripping the main switch, inasmuch as it is necessary to unlock the curved handle from the secondary socket connection and to bring it forward before commencing to pull back the carriage, and this would of itself trip the switch handle. Moreover, it is beyond the strength of an ordinary man to draw the carriage back by a direct pull, so that it becomes necessary to operate the rack and pawl arrangement in the reverse direction until the contacts are clear. This set of provisions is distinctly superior to the use of protective devices consisting of concrete cells and padlocked doors "only to be operated by authorised persons," and the gear thus in effect exceeds the recommendation of Mr. G. Scott Ram in his recent report to the Board of Trade that all exposed conductors must be guarded, inasmuch as there are no exposed conductors whatever, as the iron door immediately folds over the contact tongues on the withdrawal of the carriage. The interlocking mechanism between the doors and the switch carriage consists of a round iron rod which, during the first portion of the travel of the carriage, moves with it, and carries the pivot of the double hinge on which the doors depend, backing into the space between the upper and lower ranges of plug contacts. When, however, the doors have been completely housed, which is accomplished in the first half of the carriage travel, the interlocking rod is guided by means of special slides through a quarter turn, and the pin locking it on to the carriage is thus conducted into a slot, leaving the carriage free to travel independently of the rods. In this way the iron doors are carried out of the way of the carriage at an early stage in the movement, leaving the path clear for the contacts to engage.

The current transformer used in connection with the feeder panels for this gear is interesting, from the fact that it consists of an iron core of circular form upon which the secondary turns are wound, and the primary consists simply of the main cable threaded through the bore of the porcelain insulator in the centre of the transformer, a construction which renders the chance of breakdown, even under abnormal conditions, very remote. The protection of the current transformers is rendered perfect by the design of the iron-

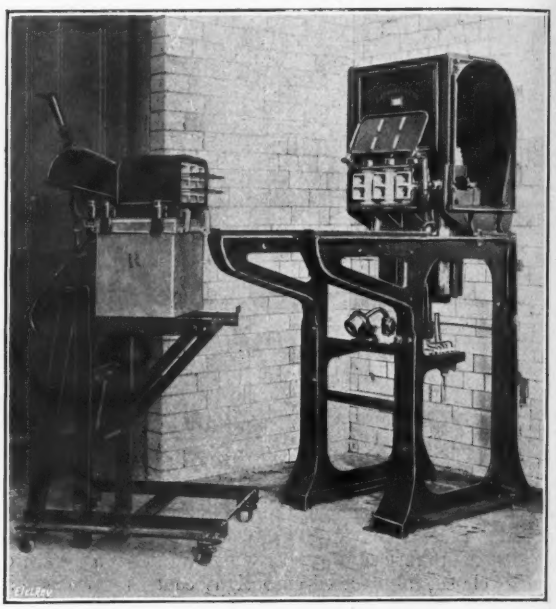


Fig. 11.—Medium-Pressure Panel (up to 3,000 volts).

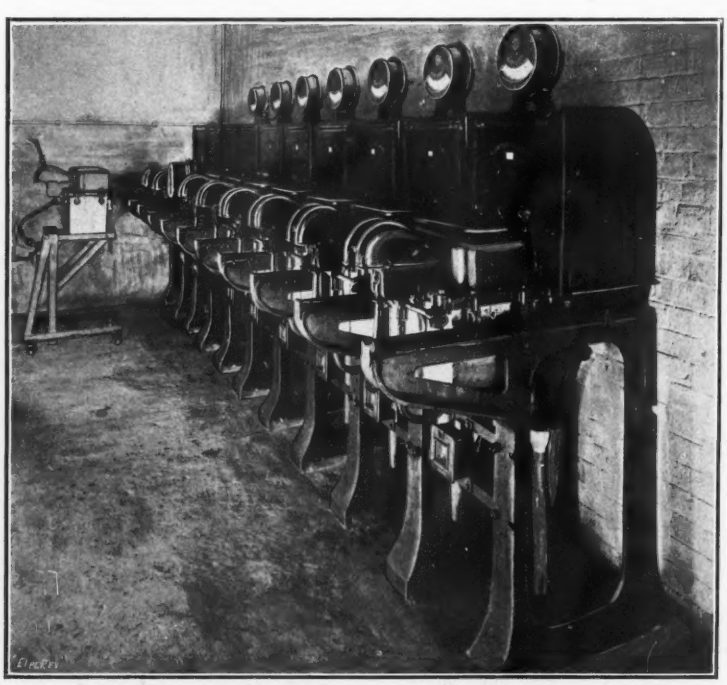


Fig. 10.—Low-Pressure Switchgear, Walker Sub-Station.

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clad chamber, filled with compound, which is prevented from leaking by means of specially grooved flanges packed with rope joints. A system of coloured leads has been adopted for all secondary connections, by means of which the leads can be readily traced, assisting the erectors in their work, and avoiding the chance of mistake. A detail which, though small in itself, gives evidence of the careful consideration which the design has received, is that the door carrying the relays of the Merz-Price or other description, is placed on hinges, and after the withdrawal of the socket plug, the whole relay gear can be swung forward, leaving the space below the oil tank free for entrance to anyone who wishes to get at the dividing box at the back.

The apparatus has, of course, been subjected to the regulation tests for extra high-pressure machinery, but its insulating qualities have largely out-distanced those usually specified. For example, every panel sent out is tested to three times its working pressure before leaving the works (Reyrolle & Co. firmly believe in reliable insulation at the outset, to avoid trouble in the future), and it is possible to play upon the whole gear with a hose pipe while in actual operation on high-pressure transmission. In one case the gear was subjected for three hours to the searching action of hot vapour generated from a bucket of water boiling directly underneath, while a pressure of 25,000 volts was applied during the three hours. No incident occurred disturbing to the satisfaction of the makers or their clients who inspected the test.

It is evident that a gear of this description saves a considerable amount of cost in maintenance, as there is absolutely no necessity to handle the gear after it has been first installed; this quality compares very favourably with those of other types of high-pressure switchgear in which it is necessary systematically to dust and clean all wall and switch insulators at frequent intervals. The general method of placing the panels for service in static sub-stations is to line them up on the floor, without division shelves or framework construction of any description, and the gear can be worked, if necessary, in the most exposed positions. When an overhead system of transmission is adopted, the lines are brought in through a spark gap device or lightning arresters on the top of the panels, and led out from the underside of the gear to the step-down transformers. Cleaning operations are the most frequent causes of accident, and these are eliminated now. Fig. 1, p. 139, illustrates a typical sub-station equipment, from a photograph of the gear at Messrs. Armstrong, Whitworth & Co.'s shipyard, Walker, in which three panels, each capable of operating a 1,000-KW. transformer, and two feeder panels are installed, the pressure being 6,000 volts.

It is evident that this type of gear is likely to receive careful attention at the hands of engineers responsible for the lay-out of mining equipments. In the Home Office regulations concerning electricity in mines, it is required that a space of not less than 3 ft. clear for medium pressure, or 4 ft. for high pressure, shall be left behind the switchboard, should there be any connections at the back of the board. To make the matter clear in this connection, Messrs. Reyrolle made inquiries as to whether it was compulsory to have a passage-way at the back of this new type of board, and should it be preferable for convenience in erecting to have the back of the board a certain distance from the wall, whether the space should necessarily be 3 or 4 ft.; in reply a letter was received stating that the Secretary of State had considered the switchboard described, and in view of the circumstances did not think that the requirements of No. 18 of the special rules for the use of electricity in mines as to a passage-way at the back of the board would apply. It is, therefore, evident that a new phase of switchgear design has been entered upon. Another feature which has seriously retarded the operation of extra-high-pressure supply is the veto which the Board of Trade has placed upon the use of underground sub-stations as a location for high-pressure gear, and it is not unreasonable to hope that with apparatus of the type described above such restrictions may be considerably relaxed or altogether removed in the future.

It will be seen that the principles adopted in the extra-high-pressure gear are equally applicable to low-pressure work, and Messrs. Reyrolle & Co. have developed a line of low-pressure gear, which is essentially similar to the apparatus described above. The chief points of difference are that it is not in this case necessary to carry the bus-bars in tubes filled in solid. The bus-bars for low-pressure work consist of assembled strips of high conductivity copper of length equal to the distance of centres of panels and secured one to the other by dove-tailing and clamping. Both in high and low-pressure bus-bars the clamping screws are provided with locking washers. Perfect locking of all screws and nuts has been specially attended to throughout the entire design; nothing is more annoying or dangerous in the usual type of gear than the constant necessity of tightening up bolts, &c. The same argument as regards determination of size of gear has been observed as in the case of high pressure, the only modification depending on current-carrying capacity being the variation in the size of the bus-bars; all the rest of the gear is perfectly uniform and interchangeable, the size being determined by the maximum power which the gear under consideration is likely to be called upon to break under the most abnormal conditions. The low-pressure panels are built for a working current up to 1,200 amperes, and their over-all dimensions are 1 ft. 9 in. centres, 3 ft. 6 in. deep, and 5 ft. 6 in. high. In order to secure efficient contact between the back contacts and those mounted on the sliding carriage, an insulated screw clamp is provided on each contact whereby, after the carriage has been slid into position, pressure is brought upon the contact surfaces, gripping them tightly and diminishing the contact resistance. Apparatus of this description has been used throughout the Tyneside district as well as in North Wales, and a typical sub-station is shown in fig. 10, this being taken from the Armstrong-Whitworth sub-station above referred to, and comprising the low-pressure switchgear for controlling the power of circuits the shipyard.

It will be admitted that the satisfactory operation of all switches under fault conditions depends very largely on the adoption of a suitable system of protective gear, and we propose in a further article to illustrate and describe the Merz-Price gear, advance notices of which have already appeared in the technical Press.

In the meantime, from personal inspection which we have made, by the courtesy of Messrs. Reyrolle, of the gear at their works, it appears to us that an entirely new departure has been made in switchgear design, which will largely affect the questions of simplicity and safety in the transmission of power at very high pressures. This impression is heightened by the fact that the gear is neither new nor experimental; the publication of details has been delayed until the system has been thoroughly tested, and three years of operating conditions have evidenced that a distinct step forward has been made.

Searchlight Company.—Under the new Territorial Army scheme, it has been notified that a searchlight company of the Royal Engineers is to be raised in Dover. The company will be attached to the Kent and Sussex Fortress Royal Engineers, and will be composed of four officers and 97 men. An instructor will be appointed from the 3rd Co. R.E. stationed at Dover, and he will attend at the Dover Institute for the next week or two for the purpose of enrolling members. It is hoped to raise the company in time for the annual camps, which take place at Shorncliffe on August 1st and 22nd, and this should be an easy task, considering the number of men connected with electrical work in the town, the only thing needed being for them to come forward and join.

MAJOR E. M. MARX has been appointed in command of the new Searchlight Company.

Missing Apprentice.—We wish to call attention to a notice which we have inserted in our advertisement pages, at the request of a well-known northern firm of electrical engineers, who are kindly endeavouring to restore to his parents a youth (one of their apprentices) who has been missing for the past week.

Institution Notes. — INSTITUTION OF MUNICIPAL ENGINEERS.—The Executive Committee of the Institution has issued a letter explaining the objects of the Institution to every member of the profession of municipal engineering. The membership now exceeds 200. Mr. B. Wyand is the secretary (address 10, Eagle Place, Piccadilly, W.).

CONCRETE INSTITUTE.—The first meeting of the Council of the newly-formed Concrete Institute was held on Tuesday last, the President, the Earl of Plymouth, C.B., presiding. Prior to the meeting there was a luncheon of the Council at the Ritz Hotel to meet the President, at which the chairman of the executive, Mr. Edwin O. Sachs, F.R.S.Ed., presided. He stated that the membership already exceeded 225, of whom the majority were civil engineers and architects.

CONTRACTORS' COLUMN.

(*Continued from page* 137.)

CHESTERFIELD (NEW WHITTINGTON).—Additions and alterations to licensed premises. T. S. Wilcockson, architect, Chesterfield.

CHIPPENHAM.—Houses, Lowden Hill Estate, for Light, Son & Co., Ltd., builders, Union Road; Audley Road, for Mr. Linzey; Audley Road, for Mr. Rogers.

CHORLEY.—Houses, Spendmore Lane, Coppull, for Messrs. Glover.

CLEVELEYS (near BLACKPOOL).—Proposed new parish church. Rev. R. Stowell, curate-in-charge.

CLITHEROE.—New dairy for the Clitheroe Dairy Co.

CLOWN.—Two houses in Portland Street, for J. Day; two houses in Neale Street, for J. Robinson.

COUNTY DURHAM.—New schools for the C.C., at Tudhoe Grange (1,100 children); Mount Pleasant, Tudhoe (350 children); Waldridge (250 children); New Lambton, Bournmoor (350 children); Malton Colliery, Lanchester (100 children); extensions at Washington, Greenside (Ryton Wood Side), and Hoden Colliery (Shotton).

COVENTRY.—Houses, St. George's Road, for Mann & Co.; Stony Stanton Road, for C. A. Newbold; Broomfield Road, for C. J. Smith; Villiers Street, for E. O. C. Howells, builder, St. Raglan Street; Broad Street, for C. Thomas; Crabmill Lane, for A. Harris; Kensington Road, for G. Blakeman; St. George's Road, for W. Yardley; Northfield Road, for T. Reynolds; Foleshill Road, for R. Dalton; Avon Street, for J. Taylor; St. Margaret's Road, for J. Gardner; Sandy Lane, for T. Randle.

COVERACK (CORNWALL).—Proposed new Methodist Church.

CUPAR (FIFE).—Additions to Castle Hill Public School.

DARTFORD.—Additions to Darenth Asylum. W. T. Hatch, chief engineer, Metropolitan Asylums Board, Embankment, E.C.

DENNY (STIRLINGSHIRE).—Proposed reconstruction of station for Caledonian Railway Co. Engineer, Caledonian Railway Offices, Glasgow.

DERBY (LITTLEOVER).—New Primitive Methodist Church and schools.

DEVONPORT.—Higher elementary school in Keppel Place. Thornely and Rooke, architects, 29, St. Aubyn Street, Devonport.

DINNINGTON (near ROTHERHAM).—Houses for W. C. Holmes, G. Windle, Mr. Lipscombe, and A. Holmes; houses and shop for Carr and Co.; conversion of houses into shops for Mr. Whyatt.

DONCASTER.—New Church at Woodlands Colliery. C. Hodgson Fowler, architect, The College, Durham.

Wesleyan Sunday Schools, at Woodlands, Brodsworth. P. B. Houlton, architect, Furnival Chambers, Chesterfield.

Enlargement of Balby Church.

DOVER.—Almshouses, Bowling Green Lane. Austen & Lewis, builders, 17, Randolph Gardens, Salisbury Road, Dover.

DUBLIN.—Recreation hall and library at the Royal Hibernian Military School, Phœnix Park. H. Williams, secretary, Office of Public Works, Dublin.

DUNDELA (BELFAST).—Alterations and additions to Dundela Presbyterian Church. Hill & Kennedy, architects, Belfast.

DURRINGTON (near WORTHING).—Proposed elementary school. H. P. Roberts, County Education Architect, Education Offices, Horsham.

DURSLEY (GLOS.).—Development of estate by R. A. Lister & Co., Ltd. A. W. Probyn, architect, Berkeley Street, Gloucester.

EARSDON (Co. DURHAM).—Additions to premises for the Backworth Workmen's Club.

EASTBOURNE.—Schoolroom in connection with Eastbourne College (£3,500). Head Master.

EDINBURGH.—Training institute for ladies in Inverleith Terrace (£5,000). G. L. Wright, builder.

EXETER (TEDBURN ST. MARY).—Repairs at Tedburn St. Mary School. W. B. Trick, Felixwell, St. Thomas, Exeter.

FALKIRK.—Building at Galvanising Works, Bankside, for Braby, Ltd. (£500).

FALMOUTH.—Proposed enlargement of the County High School (£900) for Education Authority.

FARNBOROUGH.—Houses, Manor Road, for R. D. McLawan; Peabody Road, for A. J. Galsworthy.

FARNWORTH.—Eight houses, Joseph Street, Mrs. Dakes; 10 houses, St. German Street, F. Wallwork.

FLEETWOOD.—One hundred cottages, secretary, Estate Co., Fleetwood; fish drying and storing shed in Copse Road, for Messrs. Marr and Sons, Ltd.

FOLKESTONE.—Additions, to 25, Earl's Avenue, for Miss de la Mare, T. E. Moody, architect and builder; additions to electricity works, Morehall, for the Folkestone Electricity Supply Co., Ltd., T. Hesketh, architect; addition to 13, The Leas, for W. Taylor, G. Camburn, architect.

GATESHEAD.—Wesleyan Methodist Church at Kibblesworth.

GLASGOW.—Buildings at corner of Pollokshaws Road and Lilybank Road, fo A. Motherwell, grain merchant, Main Street, Gorbals.

Additions to Nurses' Home, University Avenue. Master of Works, Western Infirmary.

Buildings for Skating Rink, &c., at corner of Victoria Road and Cuthbertson Street, for C. P. Crawford, Tournament Hall, Liverpool.

GOOLE.—Infectious Diseases Hospital, with administrative and laundry blocks. H. B. Thorp, architect, Goole.

New works for the Goole, Marshland and Howdenshire Pure Tillage and Cattle-fed Co., Ltd.

GOSPORT.—New Brodrick Memorial Hall at Alverstoke (£1,370); Harry Smith, architect, Star Chambers, Gosport; Lear & Sons, builders.

GRANTHAM (LINCOLNSHIRE).—Isolation Hospital. H. C. Rudkin, surveyor, 19, Swinegate, Grantham.

GRIMSBY.—Additions to police buildings (£737). Hewson & Goodhand, builders, Grimsby.

HANLEY.—E.L. installation at St. Luke's Church, Wellington. R. Scrivener and Sons, architects, Hanley.

HARLINGTON (MIDDLESEX).—Church-room. Rector.

HARROW.—Sixteen houses, Rutland Road. W. T. Batchelor, builder, 1, Grove Terrace, Squires Lane, Finchley.

Extension to Electricity Works for Harrow Electric Light Co.

Six shops in Middle Road. E. R. Purchase, architect, 20, Maddox Street, W.

HARWICH (ESSEX).—County High School. Brown & Burgess, Ipswich, architects.

HEMSWORTH (YORKS.).—Houses, Moorthorpe, for G. W. Swift; Frickley Colliery, for Carlton Main Colliery Co., Ltd.; Ackworth, for H. Robinson.

HERNE BAY.—Houses, Canterbury Road, for A. W. Woolf, builder, High Street, Hillborough Road. R. Messenger, architect, 16, High Street, Herne Bay.

HESTON.—Infant School. A. L. Lang, architect to Education Committee, Heston and Isleworth.

HINCKLEY.—Workhouse infirmary (£6,217). W. P. Grewcock, architect, Stapleton.

HINDLEY (LANCS.).—Important colliery developments for Crompton and Shawcross; two shops in Liverpool Road, Platt Bridge, for H. and F. Lomax; three houses in Swan Lane, Hindley Green, Meadows Bros.; two houses in Cross Street, for J. Rosbottom; two villas in Hall Lane, J. Oakes.

HODDESDON (HERTS.).—County School (£2,528). County Surveyor, Herts County Council.

HOLYHEAD.—Additions to Presbyterian School, Newry Street. W. Williams architect, Holyhead.

HOUGHTON-LE-SPRING (Co. DURHAM).—Houses, Station Avenue; Fence Houses, for G. Marshall and J. G. Westgarth; Durham Terrace, Silksworth, for Mr. Welford.

HUCKNALL TORKARD (NOTTS.).—Additions to Co-operative Society's premises (£1,200). W. V. Betts, architect, Basford; Donnelley and Sons, builders, Kimberley, Notts.

HUDDERSFIELD.—Bungalow residence, Netherton Moor, South Crosland, for J. M. Evans; houses, Clayton West, for S. Beckwith.

HULL.—Completion of the Public Hall. J. H. Hirst, city architect, Town Hall, Hull.

ILKLEY.—Winter Garden scheme under consideration. Town Council.

INCE (near WIGAN).—Houses, Bird Street and Keble Street, for Henry Dickinson; Bird Street, for Wm. Murray.

IRISHTOWN.—New dispensary.

KEIGHLEY (YORKS.)—Probable rebuilding of business premises, Oakworth Road, for Mr. Simpson, after fire.

KETTERING.—Houses, Russell Street, for Phillips & Slow; shop and offices Market Place, for L. Bagshaw; additions to factory, Crown Street, for Chater & Sons, boot manufacturers.

KENILWORTH.—Houses, Barrowell Lane, for Mr. Schneider; Windy Arbour, for A. Cay; Rosemary Hill, for T. Hughes.

KIDDERMINSTER.—New Swedenborgian Church (£2,000). Pritchard and Pritchard, architects, Bank Buildings, Kidderminster; E. Thompson, builder, Park Lane, Kidderminster.

Power house for Brintons, Ltd., carpet manufacturers; house, Villers Street, for F. Thomas.

KIRKBY-IN-ASHFIELD (NOTTS.).—Houses, Cookson Street, for J. P. Adlington; Prospect Street, for S. Coleman; Erewash Street, for R. Stow; Forest Street, for J. Hibbert.

KIRKHILL (INVERNESS-SHIRE).—New United Free Church.

KIVETON PARK (near SHEFFIELD).—Houses for Moore Bros.

LEIGH (SOUTH LANCS.).—New Hippodrome. Prescott & Bold, architects, Leigh.

LINTHWAITE (YORKS.).—Extensions to Burdett Mills, for Armitage Bros.; houses, Springmill, Lunn & Kaye, architects, Huddersfield; shop, Manchester Road, for Alfred Schofield; Pymroyd Lane, for D. T. Haigh and J. W. Hirst.

LITTLEHAMPTON.—New St. James's Church.

LIVERPOOL.—Secondary School, Cambridge Road, Seaforth, for the Lancs. C.C.

LIVERSEDGE (YORKS.).—Houses, junction of Benjamin Street and Union Road, for D. Beaumont; junction of Tichborne Street and Halifax Road, for Miss C. Kellett.

LLANDUDNO.—Houses, Mostyn Avenue, for Cowell & Keogh.

Villa Residence in Abbey Road. J. Robert, Bryn Celyn, Llandudno.

LLANDWROG (CARNARVON).—New Sunday School and Chapel House at Bwlan. R. Ll. Jones, Carnarvon.

LLANELLY.—New synagogue in Victoria Road.

LONDON (FINCHLEY, N.).—North Finchley Congregational Church to be electrically lighted.

(REGENT'S PARK, W.).—Alteration and relighting of the Church of St. Mark. Rev. M. Bell, Vicar.

(CAMBERWELL, S.E.).—Working-class dwellings in Pitman Street Wm. Oxtoby, borough surveyor, Town Hall, Peckham Road S.E.

(HACKNEY, N.E.).—Buildings in Spring Hill. J. Hamilton, architect, 23, Wormwood Street, E.C.

(KILBURN, N.W.).—Additions to St. Luke's Church. J. T. Lee, architect, 26, Great James Street, W.

(PICCADILLY, W.).—Additions to Cavalry Club. Mewes & Davies, architects, 6, Dean Street, Soho, W.

(CHELSEA, S.W.).—Bottling store, for Whitbread & Co. A. architect, 16, Holland Villas Road, Kensington, W.

(HANOVER SQUARE, W.).—Building in Eccleston Place. S. F. Monier-Williams, surveyor, 83A, Chester Square, Victoria.

(OXFORD STREET, W.).—Alterations to Baptist Church, Castle Street. T. J. Evans, architect, 61, Munster Road, Fulham, S.W.; Lyne & Sons, builders, Clapham, S.W.

(NORBURY).—Sixty-three cottages for L.C.C. W. Smith & Sons, builders, Croydon.

(WEST HAM, E.).—Enlargement of St. James's School and Custom House School. F. E. Hilleary, Clerk to Education Committee.

(WILLESDEN, N.W.).—New warehouses Salusbury Road. Scott and Fraser, architects, 10, Basinghall Street, E.C.

(HARLESDEN, N.W.).—Six houses. H. Fowler, builder, 129, Chiswick High Road, W.

(WILLESDEN, N.W.).—Addition to Langley House Laundry, 5, Bourke Road, for C. Batty.

(BREAD STREET, E.C.).—Extensions for William & Son, trimming manufacturers. Hall, Beddall & Co., builders, Pitfield Wharf, Waterloo Bridge.

(CLAPHAM).—Twenty-three houses. S. Rashleigh, builder, 28, Tregothnan Road, Stockwell, S.W.

(W.C.).—Re-erection of Freemasons' Hall and Tavern, Great Queen Street. Brown & Barlow, architects, 12, Norfolk Street, Strand, W.C.

(CLAPHAM).—Thirty-seven houses. W. H. George, builder, 10 Broomwood Gardens, West Side, Clapham Common, S.W.

(CHELSEA, S.W.).—Buildings in Church Street. Elms & Jupp, architects, 25, Sackville Street, W.

(WANDSWORTH, S.W.).—Education divisional offices for L.C.C. (£4,340). H. L. Holloway, builders, Church Street, Deptford.

(CLERKENWELL, N.).—Alterations to stores. W. E. Riley, superintendent architect, L.C.C.

(WANDSWORTH, S.W.).—Eleven houses in Wimbledon Park Road. W. C. Poole, architect, 62, Belleville Road, Wandsworth Common, S.W.

(ISLINGTON, N.).—Extensions, &c., to Police Station (£4,400). J. Dixon Butler, Surveyor to Metropolitan Police, New Scotland Yard, S.W.

(WEST HAM, E.).—Hall and Sunday School (£3,150). Percy K. Alton, architect, Lyndhurst Gardens, Tunbridge Wells.

(E.C.).—Alterations to premises in Bridewell Place. Read and Wilkinson, builders, 20, High Street, Wandsworth.

(W.)—Alterations to 46, Oxford Street, prior to occupation by Aerated Bread Co., 24, Eastcheap, E.C.

(EAST HAM, E.).—Four shops and houses. J. Harding, builder, 49, Heigham Road, East Ham, E.

LONDON (W.).—Extensions by Dickins & Jones, Ltd., silk mercers, 230, Regent Street, to Nos. 226 and 228.

(EAST HAM, E.).—Six houses in Blenheim Road. T. Watson, builder, 74, Ruskin Avenue, Manor Park, E.

(BATTERSEA, S.W.).—Storehouse for Metropolitan Water Board (£4,000). Wm. B. Bryan, chief engineer, Metropolitan Water Board, Savoy Court, Strand.

(MARYLEBONE, W.).—Depôt buildings in Grove Road. J. P. Waddington, Borough Surveyor, Town Hall, Marylebone Lane, W.

(HAMPSTEAD, N.W.).—Storerooms at Electric Lighting Department. G. H. Cottam, chief electrical engineer, Hampstead Town Hall.

(BARNES, S.W.).—Depository, Arundel Terrace. W. G. Hunt, architect, 17, Vicarage Gate, W.

(FINCHLEY, N.).—Nine houses. H. F. Nicholls, builder, Holden Road, Finchley.

LUTON.—New schools for the T.C., Beech Hill. J. R. Brown & Son, architects, Castle Street, Luton.

MACHYNLLETH.—Two semi-detached villas in Newtown Road. R. W. Davies, architect, Carno, Machynlleth.

MANCHESTER.—New elementary schools at All Saints' (1,214 children) and Oswald Road, Chorlton-cum-Hardy (£16,150) for the T.C.

MARKET RASEN.—Wesleyan Chapel at North Owersby. J. G. Glew, architect, Market Rasen.

MANSFIELD.—Houses, King Edward Avenue, for S. F. Moss; Derby Street and Cavendish Street, for C. G. Chapman; Victoria Street, for J. A. Beck; Oxford Street, for G. Wade; Thoresby Street, for C. G. Percival, builder, Newcastle Street; Bould Street, for Hill Bros.; new Church, St. Lawrence, Peck's Hill and Skerry Hill, for the Vicar and Churchwardens of St. Peter's.

MARGATE.—Houses, Westbrook Avenue, S. E. Burrows, architect, 8, Cecil Street, Margate; Westbrook Esplanade, Reeve & Reeve, architects, Margate.

MARKET HARBOROUGH.—New Nursing Home (£2,000).

MARLBOROUGH.—New Church Institute.

MARKET DRAYTON.—Secondary School for Salop C.C. J. Holt, architect, 6, St. Mary's Gate, Manchester.

MELBOURNE (DERBYSHIRE).—House, Station Road, for C. Hough, Derby.

MELTON MOWBRAY.—New Working Men's Club. Joseph E. Wakerley, architect.

Villa in Craven Street West, for Mr. Denman.

MERE (WILTS.).—Engine house for the R.D.C. J. McKenzie, town surveyor, Castle Street, Mere.

MERTHYR TYDFIL.—Thirty-eight houses, Danyderi, Merthyr Vale. T. A. Rees, Town Clerk, Merthyr Tydfil.

New Higher School for 500 children. J. L. Smith, Architect to the Education Committee, Town Hall, Merthyr Tydfil.

Enlargement Gellifaelog School, Dowlais, to provide for 388 extra children. J. L. Smith, Architect to the Education Committee, Town Hall, Merthyr Tydfil.

New infants' school (500 children), Dowlais. J. L. Smith, Architect to the Education Committee, Town Hall, Merthyr Tydfil.

MIDDLETON (LANCS.).—New elementary school, Durnford Street, for the T.C. Edgar Wood, architect, 78, Cross Street, Manchester.

MILFORD (SURREY).—Renovation of the parish church. Vicar.

MIRFIELD (YORKS.).—Installation of the electric light at Hopton Church.

MITCHAM.—Wesleyan Church. Geo. E. Everitt, builder, 79, Windmill Road, Croydon.

MORRISTON.—Proposed new Y.M.C.A. premises (£5,000).

MORTLAKE.—New infants' school for the Surrey Education Committee (£3,430).

MOUNTAIN ASH.—New church at Miskin for the Rev. J. S. Jones. E. M. B. Vaughan, architect, Dumfries Place, Cardiff.

NEATH (ONLLWYN).—Vestry at Maesymarchog for the trustees of the Welsh Independent Congregational Chapel, Onllwyn. T. E. Richards, architect, Pontypridd.

NEWLYN.—Proposed new Primitive Methodist Church in Church Lane (£3,000). Rev. J. H. Howlett, minister, Primitive Methodist Church, Boase Street, Newlyn.

NEWQUAY (CORNWALL).—County Secondary School. B. C. Andrew, architect.

NORTH ANSTON (near ROTHERHAM).—Houses for Mr. Coggan and Mr. Reynolds.

NORTHWOOD.—New offices for the Urban District Council.

NORWICH.—Renovation of Chapel-in-Field Church and school buildings (£250).

NOTTINGHAM.—Extension of the Nottingham School of Art, and installation of the electric light throughout, under consideration.

New bleaching and dressing works at Bagthorpe for A. J. Taylor. A. H. Goodall, architect, Wheeler Gate, Nottingham; Thos. Barlow & Co., builders, West Bridgford, Nottingham.

New church hall for St. Mark's Parish (£950). A. E. Heazell, architect, Burton Buildings, Parliament Street, Nottingham.

OUGHTERSIDE (ASPATRIA).—School extensions for Cumberland C.C. (£1,297). E. Musgrave, builder, Carlisle.

OXTED (SURREY).—House, Barrow Green Lane, for Mr. Crittenden.

PAISLEY.—Alteration and enlargement of St. Columba Gaelic Church (£2,080).

PENDLEBURY (LANCS.).—Institute, Broomhall Road, for Miss M. Heywood.

PENYGROES (CARNARVON).—Additions to Llanllyfni Council School. Rowland Lloyd Jones, architect, 14, Market Street, Carnarvon.

PENZANCE.—New County School for Boys, at Treneere, for the Cornwall Education Committee. S. Hill, architect, Green Lane, Redruth.

PONTYPRIDD.—Alterations to brewery premises. Geo. Adlam & Sons, architects, Bristol.

Y.M.C.A. buildings. V. Hodge, architect, Teddington.

Alteration to premises. A. Ll. Thomas, architect, Pontypridd.

Twenty houses. A. O. Evans, Williams & Evans, architects, Pontypridd.

RAWMARSH (YORKS.).—Houses, Green Lane, for Henry Wright & Geo. Walsh; Infirmary Road and Thrybergh View, for Dawson and Briddon; Dale Road and Chapel Street, for Jabez Jackson; Ashwood Road, for Hiram Wilson; Main Street, Ryecroft, for J. P. Claye.

RAWTENSTALL.—Proposed alterations to Waterfoot Market Buildings. J. Johnson, Borough Surveyor, Municipal Offices, Rawtenstall.

READING.—Alterations and additions at Reading School for the Education Committee. Ravenscroft, Son & Morris, architects, 22, The Forbury, Reading.

RHYMNEY (MON.).—Additions to the Rhymney Brewery, for A. Buchan & Co. T. Roderick, architect, Clifton Street, Aberdare.

ROCHDALE.—Conversion of old steam tramway depôt into motor garage, for W. H. Waller.

Renovation of the Hamer United Methodist Church (£400).

ROTHERHAM.—New St. Peter's Church, Whinney Hill, Thrybergh (£1,180). J. E. Knight, architect, Rotherham.

RUGBY.—Tailor's workshop and Educational Hall, &c., for the Co-operative Society. Franklin & Newman, architects, Rugby.

Factory, Lower Hillmorton Road, for the manufacture of electric lamps. Rugby Lamp Co., Ltd., owners.

ST. CLEARS.—Two villas near station. George Morgan & Son, architects, 24, King Street, Carmarthen.

SANDOWN (ISLE OF WIGHT).—Houses, The Avenue, for W. C. Clark; Victoria Road, for J. E. Radford; North Street, for A. J. Chambers; nineteen houses, for W. J. Payne; eight houses, Sandown Road, for L. A. Moorman.

SALTASH.—Y.M.C.A. Hall in Fore Street (£900).

SEVENOAKS.—Extension to the Laundry for the Sevenoaks Guardians (£300).

SHEFFIELD.—Primitive Methodist Chapel at Over Heage. W. G. Smithson, architect, 13, Bond Street, Park Row, Leeds; J. Spendlove, builder, Heage.

Proposed Primitive Methodist School Chapel at Dalton Brook (£800).

Underground Lavatories, tramway office, and other works, for the T.C. City Engineer, Sheffield.

SHOTTON (Co. DURHAM).—Alterations to premises for the Shotton Colliery Workmen's Club, Ltd. Secretary of the Club.

SHREWSBURY.—New place of worship, Coton Hill (£3,500). A. B. Deakin, architect, 12a, Pride Hill, Shrewsbury; T. Pace, builder, Berwick Road, Shrewsbury.

SIDMOUTH.—Enlargement and adaptation of buildings for new police station. E. H. Harbottle, County Surveyor, Queen Street, Exeter.

SLOUGH.—Houses, Datchet Road, for J. Shackles; Arthur Road, for Mr. Cozens; King Edward Street, for N. Grove; White Hart Road, for H. D. Bowyer, builder, Mackenzie Street; Green Lane, for M. Holdway; Chalvey Road, for the Co-operative Society; house and stables, High Street, for Col. W. N. Davis.

SOUTH BANK (YORKS.).—New County Schools (£9,344). Howe & Co., builders, Whitby Street, Hartlepool.

SOUTH MOLTON (DEVON).—House for Sir Thomas Acland; house, East Street, for N. J. Holcombe.

SOUTH SHIELDS.—Two new churches in connection with Saville Street Primitive Methodist Church.

New premises for the Y.M.C.A.

SOUTHWELL.—Proposed Parish Hall in Easthorpe (£2,000).

STAFFORD.—Additions to 57, Marston Road, for Thos. Follows; additions to 16, Tipping Street, for Siemens Bros. Dynamo Works, Ltd.; Cottage, Wright Street, for Thos. Herbert, builder, 90, Wright Street.

Institute in connection with St. Thomas' Church for Rev. W. S. Allison.

STALYBRIDGE.—Car-shed extensions for the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board. R. Blackmore, chief engineer.

STAMFORD.—Additions to works for the Martin Cultivator Co., Ltd. T. J. Ward, architect, Stamford.

STANSTED ABBOTTS.—Enlargement of the Congregational Church.

STEVENAGE (HERTS.).—County school (836 places). County Surveyor, Herts County Council.

STOURBRIDGE.—Extensions to the Secondary School for the U.D.C. Fredk. Woodward, architect, Town Hall, Stourbridge.

STRATHPEFFER, N.B.—Renovation of Contin Parish Church.

SUTTON-IN-ASHFIELD (NOTTS.).—Houses, Silk Street, for Mrs. Renshaw; Hardwick Lane, for Miss Coleman; Charnwood Street, for L. E. Sidebottom; Church Street, for R. S. Bailey.

SWADLINCOTE.—Houses, Belmont Street, for Earp & Thorpe; Sunnyside, Newhall, for Ben Warren; Sunnyside, Newhall, for G. H. Hibberd.

SWANAGE.—Two semi-detached houses in King Street, for Burt & Burt; garage at Grand Hotel, for S. M. Davis.

SWANSEA.—Extensions at the hospital. G. Moxham, architect, Castle Street, Swansea.

SWINDON.—Houses (144), A. J. Colborne, builder, Swindon; Ashford Road, for J. Bennet; Okus Road, W. J. Rogers, builder, Okus Road.

SWINTON (LANCS.).—Seven houses, Moss Lane, for J. McDowall; four houses, Cemetery Road, for J. Newton.

TADCASTER.—New Wesleyan Church at Allerton Bywater.

TAUNTON.—Addition to St. Mary's vicarage. Sprankling & Price, architects.

House in Belvedere Road, Taunton. Mr. Ashman.

Two houses in Salisbury Terrace. Mr. Rabjohns, builder.

Two houses, Leslie Avenue. Mr. Rabjohns, builder.

THORNLEY (Co. DURHAM).—Villa residence at High Wheatley Hill. H. F. Cowx, Avenue Hotel, Whitley Bay.

TONBRIDGE.—New Y.M.C.A. premises.

TYNEMOUTH.—Economiser house, &c., at the workhouse for the B. of G. J. P. Spencer, architect, 30, Howard Street, North Shields.

ULVERSTON.—Turbine house, Summerhill, Haverthwaite, for Mrs. Altham.

WALTON-ON-THE-NAZE.—Jewish Convalescent Home on the Naze High Cliff (£23,000). Messrs. Lawrence, builders, Westminster, London, S.W.

WARE (HERTS.).—Houses, Hailey Lane, Great Amwell, for H. W. Green, Bengoe; kennels, for G. R. Smith-Bosanquet, Broxbornsbury.

WAREHAM.—Proposed new stores in South Street. W. E. Randall, builder.

WARLINGHAM (SURREY).—House for R. Davison; alterations at Melrose, for J. R. Ford.

WARSOP (NOTTS.).—House, Wood Street, for F. J. Robinson; additions to house, High Street, for Sir Hugo FitzHerbert.

WATERLOO (near LIVERPOOL).—Houses, Picton Road and Oxford Road, for J. and A. Burroughs; alterations and additions to the L.L. Station, Brighton Road, for the Liverpool District Lighting Co., Ltd.; billiard room, for Stephen Ashcroft, Haigh Road, Waterloo Park.

WAUNLLWYD (MON.).—Shop for the Ebbw Vale Co-operative Society. H. Waters, architect, Market Chambers, Ebbw Vale.

WEDNESBURY (DARLASTON).—Primitive Methodist Church at King's Hill (£2,000).

WHEATHAMPSTEAD (HERTS.).—County School (£937). County Surveyor, Herts. County Council.

WHITEHAVEN.—Reconstruction of premises at 33, 35, and 37, James Street, and alterations to shops, Roper Street. J. N. Singleton, architect, 61, Lowther Street, Whitehaven.

WIDNES.—Ten houses, Foster Street, for E. Wood.

WOOLWICH.—Additions to the Standard public-house. Gardiner & Theobald, architects, 110, Great Russell Street, W.C.

Proposed buildings for the Army Medical Corps in Shooter's Hill Road.

WORSLEY (LANCS.).—Five houses, Wilfred Road, for J. Hallam; four pairs of villas, Hardy Street, for J. Tyldesley.

YORK (BISHOPTHORPE).—Alteration to the Parish Church (£250).

NOTES.

British Association for the Advancement of Science (Engineering Section).—The following is the provisional programme for the meeting at Dublin:—

Thursday, September 3rd.—Address by the President of the Section, Dugald Clerk, F.R.S.

Friday, September 4th.—Report of the Committee on Gas Explosions, to be followed by a discussion jointly with members of the Physical and Chemical Sections.

Monday, September 7th.—"Recent Advances in Steam Turbines," by Gerald Stoney, M.Inst.C.E.

"Producer Gas," by J. Emerson Dowson, M.Inst.C.E.

"Suction Gas Producers," by P. W. Robson.

"The Utilisation of Peat for Making Gas on Charcoal," by Capt. H. Riall Sankey, R.E.

Tuesday, September 8th.—"The Laws of Flight," by F. W. Lanchester.

"On the Causes of Wear in Motor Vehicle Machinery," by F. H. Royce, M.I.Mech.E.

"On a Fundamental Error in the Theory of Power Transmission by Belts," by W. Worby Beaumont, M Inst.C.E.

"Railless Traction," by F. Douglas Fox, M.Inst.C.E.

Legal.—ACTION AGAINST WOLVERHAMPTON ELECTRICTY DEPARTMENT.—At Wolverhampton County Court on Monday—before Judge Howard Smith—the Wolverhampton Corporation Electricity Department were respondents in an action brought by Hugh McCrudden, who sought to recover under the Workmen's Compensation Act damages as compensation in respect of an injury sustained while working in the electricity department. McCrudden was formerly employed as a wireman by the Corporation. On December 30th he was working at a fitter's bench in the generating station, when an anvil weighing about 30 lb., which he was hammering on, fell on to his left foot. Although in pain, McCrudden continued working, but later he told the foreman about the accident, and on getting home he found his foot was crushed, and in some parts swollen. Next day he absented himself from work owing to the injury, and on returning to his duties he was told to get his money, and that his services were no longer required. Considerable correspondence arising out of the accident was read to the Court by Mr. Eddy, barrister, who appeared for McCrudden, and in one letter from Mr. C. E. C. Shawfield, the borough electrical engineer, it was stated that McCrudden had not notified any official of the mishap, and further that he was discharged owing to some work he had done. In cross-examination by Mr. Lawrence, barrister, who represented the Corporation, McCrudden said he did not know that complaints had been made about his work. It was, he admitted, a fact that he had been injured through accidents while working for other firms, and in one case had accepted £10 as compensation, instead of taking proceedings. Three times he had met with accidents while following his employment, the foot injured in the present case having been previously hurt. Evidence having been given by two fellow workmen, and by two doctors, Mr. Lawrence submitted that the claim was put forward by McCrudden in a grossly exaggerated way, and, he alleged, was practically a bogus one. The judge said it was a proper case for investigation, inasmuch as he was sure there was a suspicion about the *bona fides* of the claim. He believed applicant had not properly described the accident, and that he had grossly exaggerated the facts. His Honour awarded McCrudden £12 15s. and costs, and found that there was now no incapacity resulting from the injury.

Territorial Electrical Engineers.—According to the *Gazette*, Lieut. J. F. Lister, A.M.I.E.E., from the London Division (Electrical Engineers) R.E. (Vols.), is promoted to be Lieut.-Colonel.

Satisfactory progress is being made in the formation of an electric light corps (Devon Royal Engineers) in connection with the Territorial Army. Although this special branch did not commence to enlist until the other arms had made a start, the applications received by Capt. J. H. Prior, D.S.O., at Mutley Barracks, Plymouth, have been highly gratifying. A good number of young men engaged in electrical and engineering work have decided to serve, and only a few more are required for the necessary steps to be taken to have this corps recognised by the Army Council.

Naval Electricians.—It is officially announced by the Admiralty at Devonport that it has been decided to authorise, as a temporary measure, the transfer of armourers to the rating of electrician, subject to the following special provisions:—(1) The privilege of transfer is to be limited to chief armourers and armourers passed for chief armourers, who have shown marked mechanical ability and general efficiency; (2) men who desire to present themselves for examination for transfer to electrician must be reported to possess sufficient ability to pass the educational and trade examination prescribed for candidates from the shore; (3) the candidates selected are subsequently to undergo a modified electrician's course on board H.M.S. *Vernon* or *Defiance*, and at the conclusion of the course to pass the examination for acting electrician, fourth class, as prescribed above; (4) men who pass this examination may be transferred to the rating of acting electrician, fourth class, by order of the Commander-in-Chief, and they are to receive the pay and wear the uniform of their new rating from the date of the Commander-in-Chief's approval. It is not at present intended to prescribe a definite limit of age at which transfer may be allowed, but in considering applications for transfer, each case is to be dealt with on its merits, preference being given to young men.

Fire Brigade Competitions.—In the annual competition of the London Private Fire Brigades at the Crystal Palace on Saturday last, the Robertson Fire Brigade again won the shield presented by Sir Thomas R. Dewar for the best drill. In the championship totals the Robertson Brigade came out second out of 23 competing brigades, the aggregate time for all the drills being 348 secs., against the winners' 342 secs. It was unfortunate for the Robertson Brigade that whilst their "5-men drill with water" was being run there was a sudden squall, the wind being so strong that it broke the jet into a fine spray and prevented them from dislodging the target. Owing to this the Robertson Brigade lost over 34 secs., otherwise they would have again easily won the championship of the Association.

Angola Rubber Developments.—The Portuguese Province of Angola occasions a heavy yearly deficit to the Government, chiefly due to the lack of capital for the exploitation of the rubber forests and the great competition of the Congo State. The Government have now decided to make an effort to develop the region, and will accept the proposal of a group of Belgian capitalists, who offer to exploit the district of Lunda, the richest in the region of Angola, and bordering on the Congo territory. They propose that the Government shall receive 50 per cent. of the profits, and that all the export of the rubber shall be done through the Portuguese port of Loanda.

Appointment Vacant.—ALEXANDRIA.—Chief assistant to chief engineer, municipal electrical supply station (£420, rising to £480). Apply to M. l'Administrateur de la Municipalité d'Alexandrie, Egypt, by October 15th.

Lightning.—During a violent storm near Poitiers, 13 out of 14 people on a farm were killed by lightning, and not one of the cattle escaped.

Educational Notes.—BIRMINGHAM TECHNICAL SCHOOL.—A course of lectures on wireless telegraphy is to be given by Dr. W. E. Sumpner. As many of the probable students for this course will be members of the Telegraph Engineers' Corps of the Territorial Army, it has been arranged for Capt. Iles, the Adjutant of the Corps, to be associated with Dr. Sumpner in the conduct of the class, and he will bring with him apparatus actually in use in the Army for this purpose.

UNIVERSITY OF MANCHESTER.—The new session begins on October 6th; special courses are provided for electrical engineering students, and the B.Sc. degree is awarded in Engineering and Physics.

KING'S COLLEGE, LONDON.—The 1908-9 session begins on September 30th. Day and evening classes are held in engineering, and the B.Sc. degree of London University is awarded.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW posted as to their movements.

Central Station Officials.—The Finchley District Council has agreed that the salary of the electrical engineer (MR. E. CALVERT) shall be increased from £450 to £475 per annum, such increment to take effect from July 1st.

MR. J. E. DONOGHUE has resigned his position of chief assistant electrical engineer to the Sydney Municipal Council, to take up the appointment of chief engineer to the new Electric Light and Power Supply Corporation, Ltd., Balmain, Sydney.

The Burton-on-Trent Electricity Works staff has presented a number of electrical books to MR. THOMPSON, who has been appointed station superintendent at Carlisle.

Tramway Officials.—On June 30th the Recreation Ground was formally opened at the depôt of the Falkirk and District Tramway Co. MR. D. HAYS, manager of the company, presided. It was stated that the Recreation Ground, which a year ago was simply waste land, had been obtained by the united efforts of every man in the company's service. Mrs. Hays performed the opening ceremony, and a rose-bowl was subsequently presented to her as a memento of the occasion. Presentations were also made to several officials.

General.—The Postmaster-General has appointed LIEUT. F. G. LORING, R.N., as Inspector of Wireless Telegraphy at the General Post Office.

MR. VICTOR DELEBECQUE has relinquished his appointment as Manchester representative of the Electric and Ordnance Accessories Co., and has taken up the duties of Birmingham manager for Messrs. J. Rhodes & Sons, Ltd., Wakefield.

MR. W. COHIN, of Launceston, Tasmania, has been appointed electrical engineer for the Department of Public Works, New South Wales, with a salary of £750 per annum.

Additional presentations have been made to MR. C. C. HAWKINS, late head of the electrical department at the works of Messrs. W. H. Allen, Son & Co., Ltd., Bedford. From the staff he has received a Westminster chiming clock, and from the men of the dynamo shop a case of briar pipes.

MR. F. W. WILSON has been appointed electrical inspector under the Government of Bombay.

Obituary.—We regret to record the death, in his thirty-fifth year, of ARTHUR CROSLAND HANSON, late burgh electric engineer, Stirling.

CITY NOTES.

The Bombay Electric Supply and Tramways Report.

This undertaking, which is under the control of the British Electric Traction Co., being one of its subsidiary flotations, is undergoing conversion from animal to electric traction, and it is, therefore, probably somewhat premature to discuss what the promotion is likely to do for the ordinary shareholder. At the present time it requires £27,000 per annum to satisfy the interest on the debenture stock, and when the preference shares have been fully paid, the preference dividend will need a sum of £36,000 per annum. It is significant that whereas the British Electric Traction Co. apparently owned shares and so forth in the Bombay Co. at March 31st, 1906, of a par value of £240,714, that holding had been reduced to £114,328 at March 31st, 1908. Is this conversion ostensibly for the benefit of the electrical industry? Does it mean a policy of "getting in" and "getting out" with the ultimate retention of only such an interest as will ensure the maintenance of paramount control?

A noticeable paragraph of the report for 1907 states that the board has concluded an arrangement with a syndicate in Bombay to take up the balance of the ordinary shares, and that these shares were offered by the syndicate for subscription in Bombay in February last.

Considerable progress has been made both in the electric supply and tramway sections, and complete electrification in the near future, and further development of the electric supply business should be reflected in increasing profits. For the year 1907 the profits only amounted to £29,000 after debiting profit and loss with £700 (proportion of a suspense account), capitalising £15,457 of debenture interest, and £2,511 administration expenses, as well as allocating to the asset of horse tramways £279 worth of additions and improvements which, having regard to the fact that the horse lines will shortly be superseded, and that when supersession takes place the book loss will be probably a permanent feature in the accounts, it had been advisable to charge to revenue, unless, indeed, Mr. Garcke is seriously contemplating adopting the "doctrine" of Messrs. Peat & Pixley as expounded in their L.C.C. report. Recasting the profit and loss account on the usual lines, the profit available for distribution is reduced to the neighbourhood of £10,000.

To exhibit it lucidly, the grouping of some of the capital expenditure leaves room for segregation and consequent improvement.

Toronto Power Co., Ltd., and Toronto Railway Co.

The first named company is issuing £500,000 4½ per cent. debenture stock, redeemable 1918, and guaranteed by the Toronto Railway Co.

The price of the issue is £98 per cent.; the stock will be secured by a trust deed constituting it a specific first mortgage upon $3,000,000 5 per cent. gold bonds, and over four-fifths of the common shares of the Electrical Development Co., of Ontario, Ltd.

The Toronto Power Co. has a share capital of $1,000,000 issued and fully paid, and the Railway Co., which operates 114 miles of line, has a paid-up share capital of $8,000,000 and mortgages, bonds and debentures outstanding to the amount of $4,069,101. With slight exceptions the outstanding bonds do not mature until 1921, or after the date of maturity of the debenture stock now offered.

The subscription list closed on Wednesday last.

Telegraph Construction and Maintenance Co.

The half-yearly meeting was held on the 21st inst., Sir James Pender presiding. He said that cable work generally had not been as active as it was last year, but he thought the company had had its fair share. The proprietors would have seen in the newspapers lately many references to damage to cables by trawlers off the English and Irish coasts. This had cost the cable companies a great deal of money for repairs and renewals. The newest cables appeared to be not so often interrupted as those which had been laid for some years, so it was probable that the trawlers did not do the mischief at once, but wore the cables out by continually dragging the trawls over them. This had kept the cable steamers very busy, and the company had been offered more repairing work of this description during the past year than they had been able to undertake. They were, however, making arrangements to build another ship specially suited for the work.

Cryselco, Ltd.

In submitting the balance-sheet and accounts for the year ending May 31st, 1908, the directors report that the business of the company continues to show a steady improvement, the profit for the year, including balance brought forward, being £6,081. The number of lamps sold shows a substantial increase, and notwithstanding the very keen competition existing throughout the year, which has necessitated a still further reduction of price, it is satisfactory to note that a larger profit has been made.

The directors have reason to believe that they will be successful during the present year in placing upon the market a metal filament lamp, which should satisfactorily replace the decreased demand for carbon filament lamps which is undoubtedly occurring. Success will necessitate an increased working capital, which the directors hope may be met out of the revenue of the company, but it is possible that it may be necessary to raise additional capital.

The directors recommend the payment of the usual dividend at the rate of 10 per cent. for the year.

East London Railway.—The report for the half-year ended June 30th states that the gross earnings over the line for the six months ended April 30th, were £21,086, against £23,640. The coaching traffic shows a decrease of £2,017, and the goods traffic a decrease of £587. Having regard to the serious losses sustained, arising out of the declining receipts from through passenger traffic, the lessee companies have, since last February, given the question of the electrical working of the line exceptional attention. Mr. C. Jones and Mr. H. W. Firth—electrical engineers respectively of the Metropolitan and the Great Eastern Railway Companies—have prepared a comprehensive report as to the best system and the cost of equipping the railway for electric traction. The matter had been referred to the general managers of the lessee companies for their report to the Joint Committee.

Electric and General Investment Co., Ltd.—The report states that the gross profit for the year was £7,891, and, after deducting all general charges and the interim dividend already paid on the preference shares, and providing for the proportion of the final dividend accrued on the preference shares to May 31st, 1908, there remained a balance of £568, which the directors have carried to the contingencies fund, thereby raising the amount to the credit thereof to £67,556 as on May 31st, 1908. The trustee for the ordinary shares reserve fund proposes to distribute the sum of 6d. per share out of the dividends received on the trust investments, and the trustee for the founders' shares reserve fund proposes to distribute a sum of £10 per share out of the dividends received on the trust investments.

Malta Tramways, Ltd.—This company invites subscriptions at par for 125,000 ordinary shares of £1 each. The company has been formed to purchase as a going concern, as from August 1st next, the tramway undertaking and passenger lift, carried on in Malta by Messrs. Macartney, McElroy & Co., Ltd., together with all the premises, assets, the goodwill and the benefit of all subsisting contracts. The tramway is an electrical one, with its own power station and other buildings. The lift operates from the Marina of the Grand Harbour, that is, the port of Malta, to the Upper Barracca, or highest level of Valletta, a height of about 160 ft., and constitutes the shortest route from the Grand Harbour and Custom House to the centre of Valletta. The average profit on the basis of the last two years is £10,388, which is equivalent to more than 7 per cent. on the whole of the capital, and it is anticipated that the future profits of the undertaking will be considerably greater. The lists close to-morrow.

Vallambrosa Rubber Co., Ltd.—The report for the year ended March 31st, 1908, states that the profit is £24,217, to which must be added the balance brought forward of £8,140, making together £32,358. An interim dividend of 25 per cent., less income-tax, was paid in December, 1907, absorbing £12,017, and leaving a balance of £20,340. The directors recommend a final dividend of 30 per cent., less income-tax (making 55 per cent.), leaving to be carried forward £5,919.

Bruce Peebles & Co., Ltd. — The joint liquidators announce that the result of the meetings held on the 10th inst. (Electrical Review, page 107) having been reported to the Court, the Judge in the liquidation has pronounced an Order allowing all creditors and other parties having an interest to lodge answers to the scheme of arrangement, if so advised, on or before Thursday, August 13th, 1908. As soon thereafter as possible, the application to the Court for approval of the scheme of arrangement will be proceeded with.

The Electric Construction Co., Ltd.—The fifteenth annual general meeting of the shareholders of this company was held on Monday at Winchester House, Old Broad Street, Mr. Walter S. B. McLaren presiding. The report will appear in our next issue.

The United River Plate Telephone Co., Ltd.—Mr. F. Green presided at Winchester House, E.C., on Tuesday over the 22nd ordinary meeting of this company, which will be reported in our next issue.

Montreal Light, Heat and Power Co.—A dividend of 1½ per cent., being at the rate of 6 per cent. per annum for the quarter ending July 31st, has been declared.

St. James' and Pall Mall Electric Light Co., Ltd.—The directors have declared an interim dividend on the preference shares at the rate of 7 per cent. per annum, and on the ordinary shares at the rate of 10 per cent. per annum, for the half-year ending June 30th.

Chili Telephone Co., Ltd.

THE nineteenth ordinary general meeting of this company was held on Thursday of last week, at the offices of the company, 42, Old Broad Street., E.C.

The CHAIRMAN, in moving the adoption of the report (ELECTRICAL REVIEW, p. 68), said that the business in Chile had been more active during the past year, and they now had a more favourable report and statement of accounts to present to the shareholders. The result of the year's business was, he thought, satisfactory, considering the acute financial crisis and labour troubles through which the country had been passing. The unprecedented depreciation in the paper currency was a serious factor in the economic conditions of Chile, causing an all-round rise in financial directions. Their general business had prospered even at a greater rate than it had been doing in the past, and was now as it was before the earthquake of 1906. The Chilian paper dollar had fallen from 13¾d. to 8¾d. during the year. The expenditure had also increased and worked out at about 50 per cent. of the revenue or about the same ratio as it was before the disastrous earthquake. The net income from Chile came out at £33,883, which was an increase over the previous year of £3,469. Interest and transfer fees amounted to £748, making a total income of £34,631. After deducting London expenses, debenture interest and income-tax, and adding the £2,727 brought forward from last year, there was an available balance of £33,817. Out of that the interim dividend paid in January last had absorbed £6,600, and £13,440 would be placed to reserve. The directors now recommended the payment of a final dividend of £11,000, making with the interim dividend a total distribution for the year of 8 per cent. on the shares, free of income-tax, leaving £2,777 to be carried forward. The whole of the outstanding 6 per cent. debentures, amounting to £12,000, had been paid off, thus leaving the business free from debenture charges. After providing for the loss in converting the currency into sterling to liquidate the assets in Chile at the lower rate of exchange, and for the replacement of plant, the reserve stood at £113,000, an increase of £10,000. The capital expenditure had increased £1,604, while the investments remained the same as last year—at cost. They still showed a depreciation of £700, compared with the market price, but they hoped as money was getting cheaper, that they would gradually return to their old figure. The company's property was being maintained to meet the requirements of the business. The extension of the double line of copper had been completed south down to Santiago in the Talca district. They had equipped and added to the mileage of wires 817 miles. A commencement had been made in placing the overhead wires in Santiago underground. The low rate of currency had somewhat retarded the development of Chile. The past year had been a difficult one for the company, and they were very much indebted to the staff for the constant zeal and energy which had brought about the success of the year's business.

MR. F. W. JONES seconded the motion, and the report was adopted.

Bombay Electric Supply and Tramways Co., Ltd.

THE third ordinary general meeting of the above company was held on Tuesday at Winchester House, E.C., under the chairmanship of Sir Edward Sassoon, Bt., M.P.

In moving the adoption of the report, the CHAIRMAN said that last year he expressed the hope that their entire system of tramways would be working electrically before the monsoon of the current year, and he was glad to say these anticipations had been realised. The whole of the lines had been working electrically since May 18th, which was two months before the period prescribed in the licence. Their revenue in the past year was derived from two sources, viz., firstly, the working of the horse and electrical tramways; and, secondly, from the electricity supply section which, for the first time, contributed to the revenue. The balance from the working of the traffic and the electricity supply section amounted to £43,442, whilst sundry receipts were £395 18s., making a total of £43,838. From this had to be deducted the proportion of London Administration and general expenses, £1,076; the amount written off the electricity supply department, £700; interest, £1,181; and debenture interest on unproductive capital outlay, £11,542; which left a balance of £29,337 to be carried to the balance-sheet. To this had to be added £1,363 brought forward, which made a total available of £30,701. The dividend on the preference shares amounted to £16,757, and that was accrued to December 31st, 1907, to £11,007, and after deducting these amounts there was £2,936 15s. left, which the directors recommended should be carried forward to the next account. The cost of working the electric tramway services had been only 38 per cent. of the receipts taken by the electric cars, but in future years it would be necessary to make some allowance for depreciation. The electricity supply section was making rapid progress, and that year it had contributed £2,000 to revenue; but the working expenses of that section represented a rather large proportion of the receipts. In order to be able to meet the demands of power users, arrangements had been made for the acquisition of a site on the eastern foreshore on which to install additional plant. The special facilities for coaling and condensation which the site afforded would enable them to generate economically, which was an essential condition where power was supplied at a cheap rate. The question of making provision for depreciation and sinking fund had occupied their earnest consideration and steps would be taken to create that fund. The additional capital outlay during the year was £334,659. The balance of £4 per share on the preference shares had been called up, but it had been necessary to raise further capital, and in the past year they made arrangements with a syndicate in Bombay for a loan of £70,000. The interest and commission on that had been treated as preliminary expenses and credited to capital account. Since the close of the year they had made arrangements for a loan of £200,000 with another syndicate, and that loan would be similarly treated in the accounts next year. Their relations with the Bombay municipality continued to be harmonious, for the authorities recognised that it was to their interest to assist them rather than hamper them, in the development of an industry which would eventually revert to them.

MR. E. GARCKE seconded the motion, and the report was agreed to.

Edmundson's Electricity Corporation, Ltd.

THIS company is issuing £100,000 5 per cent. prior lien debenture stock at par, redeemable at the option of the company in whole or in part at any time after March 31st, 1912, upon six months' notice in writing, at 105 per cent. until 1920, and thereafter at par, and similarly redeemable in the event of voluntary liquidation of the company.

Provision is also made for the redemption of the stock by means of a cumulative sinking fund of 1 per cent., commencing in July, 1912, to be applied in the purchase of stock at or below 105 per cent. or in redemption by drawings at 105 per cent. until 1920 and thereafter at par.

The stock is secured by a trust deed in favour of the trustees, by which it is constituted a specific first charge on certain debentures and debenture stock of the face value of £92,700 in various electric supply companies, and a first floating charge upon the undertaking and remaining property of the company, which stood in its books on March 31st, 1907, at £1,220,606.

The trust deed provides that no mortgage or charge upon any of the property of the company shall be created ranking in priority to the stock now offered, but power is reserved to issue further stock, to rank *pari passu* with the present issue, to a total amount not exceeding £200,000, including the £100,000 now offered.

The company is interested in the following undertakings:—Folkestone, Winchester, Salisbury, Newmarket, Melton Mowbray, Wycombe, Guernsey, Bromley, Chislehurst, Alderley Edge, Lymington, Ilfracombe, Ramsgate, Ventnor, Sandown, Newport, Cowes, Ryde, Cromer, Surbiton, Dorking, Frome, Newbury, Godalming, Weybridge, Walton, Caterham, Grantham, Stamford, Twickenham, Teddington, Hampton, Newton Abbot, Dartmouth, Camborne, Redruth, Glossop, Berwick, Hawick, Hamilton, Montrose, Brechin, Inverness, Scarborough Tramways, and Lancashire Power Co.

The profits of the company for the last three years, for which published accounts are available, have been certified as follows:—

For the year ended—	From contracting work.	From investments.	Total.
March 31st, 1905 ...	£38,618	£30,204	£68,822
„ 1906 ...	27,709	32,284	59,993
„ 1907 ...	4,058	31,480	35,538

On the basis of excluding unrealised contracting profits altogether, and charging all outgoings directly against income from investments and realised contracting profits (with the exception of a sum of £2,500 estimated to be properly chargeable against unrealised contracting profits), the accounts show a net profit for the year ended March 31st, 1907, of £24,082.

The accounts for the year ended March 31st, 1908, are not yet available, but the gross profits earned by the various undertakings are substantially larger than those for the previous year, and these profits should be still further increased by the additional earning power of the new capital, as well as by the expected normal increase from the company's general business.

The proceeds of the present issue are not required to meet any outstanding liabilities, but will be used for carrying on and developing the various undertakings and for the general purposes of the company, and it is expected will be sufficient to provide for all the requirements of the company for the next two years.

The whole of the debenture stock now offered has been underwritten by the Electric and General Investment Co., Ltd., under contract. The list of subscriptions closed yesterday.

Crompton & Co., Ltd.

THE report of the directors, to be presented at the annual general meeting, states that the output from the Chelmsford works during the financial year shows a large advance over that of any previous year, and, at the same time, further economies in the cost of manufacture have been introduced. There is a considerable increase also in the turnover of the sales department, and some important contracts have been carried out during the year. The net profit for the year amounts to £31,220 (as compared with £38,291 for the year ending March 31st, 1907, and £20,060 for the year ending March 31st, 1906), and from this figure has been deducted the sum of £1,212, representing a loss on old type stock, which, owing to the introduction of improved designs, it has been thought advisable to dispose of at less than cost. After providing for debenture interest, and other items shown in the net revenue account, there remains, with the sum brought forward from last year, an available balance of £28,216.

In view of the continued keen competition and low prices, and the general depression in trade experienced during the latter part of the year, the directors are of opinion that the results of the year's working are satisfactory. The directors propose to recommend a dividend at the rate of 5 per cent. per annum for the year, to provide £2,000 for doubtful debts and contingencies, to place £8,000 to reserve, bringing that account up to £28,185, and to carry the balance £6,103 forward.

The undertakings of the Electric Supply Corporation continue to make progress. A further sum of £9,687 has been invested during the year in shares of the Guaranteeing Co. referred to in the report for the year ending March 31st, 1905, but the directors anticipate a substantial reduction in the amounts which will be required for the remaining two years during which the guarantee has to run. Any possible loss on this head is partly covered by insurance, which, with the further amount proposed to be placed to reserve out of the year's profits, will, in the opinion of the directors, afford ample provision for this item.

In accordance with the articles of association, Col. R. E. Crompton, C.B., retires from the board of directors by rotation, but offers himself for re-election.

General Electric Co., Ltd.

The report of the directors, which is to be submitted at the meeting to-day, shows that for the year ended March 31st, 1908, the net trading profits and income from investments, &c., amount to £59,753. After deducting depreciation and debenture interest amounting to £25,030, there remains a balance of £34,723, out of which the dividend on the preference shares at the rate of 5 per cent. for the year ended March 31st, 1908, has been paid, absorbing £12,500, leaving an available balance of £22,223. This the directors recommend should be appropriated as follows:—Provision for managing directors' and employés' bonus, £2,222; provision for dividend on ordinary shares at the rate of 5 per cent. for the year ended March 31st, 1908, £18,026 10s.; to reserve account, £1,974. The reserve account stands in the accounts at £118,369, being the amount of undivided profits as at March 31st, 1907. The proposed appropriation of the undivided profit of the year ended March 31st, 1908, amounts to £1,974, giving a total reserve account of £120,343. The exceptional feature of the year has been the sudden fall of prices of raw materials, which has adversely affected the results of several departments, and has besides necessitated a considerable writing down of stocks. The factories at Salford, Witton, Birmingham and London have been well employed, and are maintained in a high state of efficiency. The development of the Osram metal filament lamp business referred to in the last report proceeds to the satisfaction of the directors. Further ordinary shares to the number of 1,466 have been allotted, during the period covered by the accounts, to the directors and staff at par. During the year Mr. M. Byng tendered his resignation as a managing director, which was accepted by the board. Mr. Ernest G. Byng, who was appointed a director by resolution of the board, dated May 25th, 1908, being eligible, offers himself for re-election.

Last year the net trading profits and income from investments amounted to £68,546. The dividend on the ordinary shares was at the same rate, and there was added to reserve £9,791.

Electrical Power Storage Co., Ltd.

The nineteenth ordinary general meeting of this company was held on Thursday of last week, at the offices, 4, Great Winchester Street, E.C., Mr. Frederick Green presiding.

The Chairman, in moving the adoption of the report, (Electrical Review, p. 108), after referring to the indisposition of the chairman of the company (Sir Irving Courtenay) which prevented his presence that day, said that the balance-sheet showed, after the payment of debenture interest, a net profit of £4,074 3s. 7d., which, with the sum of £786 11s. 2d. brought in from last year, made a total of £4,860 14s. 9d. Out of that sum the directors recommended the payment of a dividend of 5 per cent., leaving £369 6s. 9d. to be carried forward. They had spent on maintenance, renewal and repair of the plant and buildings, the sum of £3,046 9s. 6d., and they had added new plant to the extent of £3,836 18s. 10d. This was largely represented by gas engines and suction gas plant, the use of which, however, they had only had for a few months, but they had every confidence that considerable reductions in cost would follow. The business during the year had unfortunately shown a considerable falling-off when compared with the previous twelve months, and it was noticeable that this change had all occurred since November last, when the money panic took place. Up to that date they were ahead of the previous year in output, and it really seemed as if the stagnation in business might be directly traced to this cause; but the most disturbing element was the absence generally throughout the year of large contracts, which were considerably less in numbers, and far less in monetary value, than those of former years. This was not in any way due to their having received a less proportion of the work, but simply owing to the fact that there had not been the work in the market for anyone to obtain. This scarcity of orders had brought about a keenness of competition amongst the firms competing which could only be described as suicidal, and it was from this cause that they had not only had to face a diminution in business, but, although they had been paying more for lead than they had ever paid during the company's existence, the prices that they had been obtaining had not been, on the whole, as good as those of the preceding period. During the last few weeks, however, there had been a slight revival. Their chief engineer, Mr. Butler, and the company's staff were giving considerable attention to batteries for use in self-propelled vehicles, but while they were keeping the question of electric 'bus propulsion well before them, they did not intend to enter into this business until they saw their way to do so on commercial and remunerative terms.

Sir James Pender seconded the motion, and the report was adopted.

City and South London Railway Co.

The directors report that the receipts from all sources for the past half-year have amounted to £88,501 and the cost of working has been £40,964, leaving a profit of £47,537. Inclusive of the balance brought forward the net revenue account shows an aggregate total of £48,656. After making provision for the debenture stock interest, rent charge, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £32,999 12s. Out of this sum the directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks, 1891, 1896, 1901 and 1903, and that a dividend at the rate of 1½ per cent. per annum be paid upon the Consolidated ordinary stock for the half-year, leaving £1,868 to be carried forward.

The number of passengers, exclusive of season ticket holders, carried during the last three years, and dividends paid in each half-year are as follows:—

Half-year.	Passengers (exclusive of season tic. hldrs.).	Receipts (including season tckts.).	Dividend % p.a. on ord. stock.
Ended December 31st, 1905..	8,607,486 ..	£70,103 14 ..	1¾
,, June 30th, 1906 ..	9,045,120 ..	72,454 4 ..	2¼
,, December 31st, 1906..	9,104,293 ..	72,228 2 ..	2
,, June 30th, 1907 ..	10,048,780 ..	77,619 12 ..	2¼
,, December 31st, 1907..	10,732,145 ..	83,451 16 ..	1¾
,, June 30th, 1908 ..	10,891,535 ..	83,474 11 ..	1½
Total since opening of line ..	201,801,061	£1,606,651	

The receipts for the half-year have been unfavourably affected by various causes. The weather in May and June has been finer and warmer than in 1907; an exhibition at the Agricultural Hall in the summer of 1907 proved far more attractive to the public than that which has been held in the corresponding part of this year; and the London County Council's electrified tramways from Moorgate to King's Cross, and past the Angel to Highbury, were opened for traffic in July, 1907. Also since April 10th, 1908, the London County Council tramways on the south side of the Thames have been placed in direct communication, by way of Westminster Bridge, with the Angel and Highbury through the completion of the Subway from the Victoria Embankment to Theobald's Road. The lower price of coal has only to a limited extent influenced the working of the half-year.

With the exception of a sum of about £2,800, the whole of the charges for the extension to Euston, the new works at Stockwell, and the two new trains of five coaches each, ordered in the month of July, 1907, have now been paid.

The Direct United States Cable Co., Ltd.

The report of the directors for the six months ended June 30th, 1908, shows that the half-year's revenue, after deducting out-payments, amounted to £51,367, as compared with £57,055 for the corresponding period of 1907, showing a difference of £5,688, against the half-year under review. The working and other expenses for the same period, including income-tax, amounted to £24,932, leaving a balance of £26,435 as the net profit, making with £6,397 brought forward from the previous half-year, and £2,299 adjustment of income-tax, a total of £35,131. For the corresponding period of 1907, the working expenses and other payments amounted to £24,699. Three quarterly interim dividends of 4s. each per share, amounting to £36,426, have been declared and paid during the financial year, and a final dividend of 4s. per share is now proposed, together with a bonus of 1s. per share, making with the three interim dividends 4½ per cent. for the year, being a total distribution of £51,603 10s. After transferring £5,000 to the reserve fund account, the balance of £2,812 on the revenue fund account is proposed to be carried forward. The reserve fund account has been debited with £12,853 for the cost of cable maintenance, and after being credited with interest on investments, profit on sale of securities, and amount transferred from revenue, the balance now amounts to £505,196. The interests of the company were represented at the International Telegraphic Conference which was held in Lisbon from May 4th to June 11th. Two of the directors, viz., Mr. H. C. B. Underdown and Mr. E. M. Underdown, retire, and offer themselves for re-election.

County of London Electric Supply Co., Ltd.—The directors have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum, less income-tax, for the half-year ended June 30th, 1908, and an interim dividend on the ordinary shares for the same period at the rate of 4 per cent. per annum, less income-tax, as last year, both payable on August 1st, 1908.

Prospectus.—*Heswell District Power Co., Ltd.*—This company has advertised locally a prospectus inviting the public to subscribe for 29,493 shares of £1 each. A report by Messrs. T. L. Miller & Wilson, consulting engineers, accompanied the prospectus.

MARKET QUOTATIONS.

Wednesday, July 22nd.

CHEMICALS, &c.		Latest Price.	Fortnight's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	28/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£5 10	..
a Bisulphide of Carbon	per ton	£18	..
a Borax	per ton	£16	..
a Copper Sulphate	per ton	£21	£1 dec.
a Lead, Nitrate	per ton	£28	..
a ,, White Sugar	per ton	£27	..
a ,, Peroxide	per ton	£32	..
a Methylated Spirit	per gal.	2/6	..
a Potassium Bichromate, in casks	per lb.	3½d.	..
a Potash, Caustic (75/80 %)	per ton	£20	..
a ,, Chlorate	per lb.	3½d.	..
a ,, Perchlorate	per lb.	9d.	..
a Potassium Cyanide	per lb.	7d.	..
a Shellac	per cwt.	135/-	18/- dec.
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Chlorate	per lb.	3½d.	..
a ,, Crystals	per ton	£3 5	..
a Sodium Bichromate, casks	per lb.	3d.	..
a ,, Cyanide (basis 100 %)	per lb.	7d.	..

METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£80	..
b ,, Wire, in ton lots	per ton	£180	..
b ,, Sheet, in ton lots	per ton	£128	..
c Babbitt's metal ingots	per ton	£50 to £130	..
c Brass (rolled metal 2" to 12") basis	per lb.	7⅞d.	..
c ,, Tube (brazed)	per lb.	8¼d.	..
c ,, ,, (solid drawn)	per lb.	7¼d.	..
c ,, Wire, basis	per lb.	6¼d.	..
c Copper Tubes (brazed)	per lb.	9¼d.	..
c ,, ,, (solid drawn)	per lb.	9¼d.	..
g Copper Bars (best selected)	per ton	£71	£1 inc.
g Copper Sheet	per ton	£71	£1 inc.
g ,, Rod	per ton	£71	£1 inc.
c ,, (Electrolytic) Bars	per ton	£60	10/- inc.
c ,, ,, Sheets	per ton	£76	£1 inc.
c ,, ,, Rod	per ton	£65	£1 inc.
c ,, ,, H.C. Wire	per lb.	7¾d.	¼d. inc.
f Ebonite Rod	per lb.	3/3	..
f ,, Sheet	per lb	3/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha, fine	per lb.	5/6 to 6/6	..
h India-rubber, Para fine	per lb.	3/8½	3½d. dec.
i Iron Pig (Cleveland warrants)	per ton	50/-	1/4 dec.
l ,, Wire, galv. No. 8, P.O. qual.	per ton	£14	..
g Lead, English Ingot	per ton	£13 5	inc.
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8	..
d Mica (in original cases) small	per lb.	6d. to 1/-	..
d ,, ,, ,, medium	per lb.	2/6 to 4/-	..
d ,, ,, ,, large	per lb.	4/6 to 8/6	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/1½	..
p ,, rolled bars & rods	per lb.	1/2 to 1/8	..
p ,, ,, strip & sheet	per lb.	1/2½ to 1/5	..
o Platinum	per oz.	85/- to 90/-	..
e Silicium Bronze Wire	per lb.	9d.	..
r Steel, Magnet, in bars	per ton	£55	..
g Tin, Block (English)	per ton	£133 10 to £134 10	£7 inc.
n ,, Wire, Nos. 1 to 16	per lb.	1/9½	½d. inc.
p White Anti-friction Metals— "White Ant" brand	per ton	£34 to £58	..
k Zinc, Sh's (Vieille Montagne bnd.)	per ton	..	..

Quotations supplied b :—

a G. Boor & Co.
b The British Aluminium Co., Ltd.
c Thos. Bolton & Sons, Ltd.
d F. Wiggins & Sons.
e Frederick Smith & Co.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakspeare.
h Edward Till & Co.
i Bolling & Lowe.
k Morris Ashby, Ltd.
Richard Johnson & Nephew, Ltd.
m W. T. Glover & Co., Ltd.
n P. Ormiston & Sons.
o Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Co., Ltd.
r W. F. Dennis & Co.

Correction.—In our report of the Yorkshire Electric Power Co., Ltd., last week, there was a reference to the death of Sir Richard Mottram. We are happy to learn, on the authority of Sir Richard himself, that he is living and in good health; in this instance we are unable to express regret that our report was incorrect.

Anglo-American Telegraph Co., Ltd.—The directors have resolved after placing £5,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending June 30th, 1908, of 15s. per cent. on the ordinary stock and £1 10s. per cent. on the preferred stock, less income-tax. There will be a balance of £6,962 to be carried forward to the next account.

Bournemouth and Poole Electricity Supply Co., Ltd.—The directors have declared an interim dividend on the ordinary shares at the rate of 5 per cent. per annum, less income-tax, for the half-year ended June 30th last.

STOCKS AND SHARES.

Tuesday Evening.

COLD comfort is provided for the holders of securities by the events of the past few days. Prices in most departments have been weak, and almost the only section to give any token of strength is that for American Rails, which are, as usual, manipulated by the wire-pullers of Wall Street.

No limit can yet be fixed to the speed with which issues crowd upon the stage. The Toronto Power Company, Ltd., come out with half a million 4½ per cent. Debenture stock at 98, principal and interest being guaranteed by the Toronto Railway Company. There does not seem to be much special attraction about this investment.

Another fresh arrival is the £100,000 5 per cent. prior lien Debenture stock of Edmundson's Electricity Corporation, the stock being offered at par. This money should suffice to put the company on its financial legs again; and it is understood that the full amount has been underwritten at a commission which, in the circumstances, is not large. These are only two of the issues amongst the many which have appeared within the last few days, in the general markets, and others are known to be impending.

City and South London Ordinary stock, already depressed by the poor dividend, was further knocked down to 32 by the fire in the Moorgate Street tunnel, an accident attended, so happily, by no catastrophic result. Upon realisation of the small damage done, buyers came in to pick up the stock, and the price recovered to 34, which still shows a fall of 2 points on the week. The half-yearly report made it very clear that the Company suffers more heavily than ever from the competition of the tramways in North and South London.

Central London Ordinary stock fell 4, and the Deferred 1 upon the disastrous start made in the Olympic games as regards the attendance of visitors. The revision of prices charged for the Stadium seats, and the rather better weather, should make a difference to the number of visitors, but it was a pity that the start should have been so bad. Metropolitan Consolidated lost a further 2 per cent., and Metropolitan Districts at 11½ are ½ down. Even now, after the long and severe fall in Home Railway stocks, opinions differ sharply as to whether or not the end of the lane is in sight, and better prices likely to return. It may be mentioned that Bakerloo 4 per cent. Debenture at 91 has recovered the interest deducted from the price last week.

In the electricity supply division a drop of 5 points in Urban First Debenture stock is, of course, the direct result of the Edmundson's prior lien Debenture issue. The Ordinary shares have shrunk to about a sovereign, and the Preference changed hands at 37s. 6d. City of London Preference hardened ½, and other pre-Ordinary issues kept firm. St. James' and Pall Mall shares underwent no change upon repetition of the 10 per cent. dividend on the Ordinary.

Telegraph stocks and shares show a number of small advances and falls, fairly evenly divided, but no outstanding feature has presented itself. Where dividends were deducted last week, the whole, or else the greater part, has been recovered in the majority of cases. Direct United States shares continue to shrink in consequence of the report. Indo-Europeans, on the other hand, have again hardened. The Globe Telegraph and Trust shares are *ex* dividend, and show the deduction in their prices.

One of the few sensations this week has been a rise of 5 in National Telephone Deferred stock. Accompanying it are vague guesses as to what the stock will be paid off at by the Government when the company's licence runs out. As high as 140 is named as a possible return, having regard also to the funds which the concern is accumulating under one guise or another. The Second Preference are 10s. down, but the Thirds moved up a little. Chili Telephone shares have advanced again.

While Anglo-Argentine Tramways Second Preference show ½ rise, the Firsts are ⅛ down. Other traction issues have remained remarkably quiet.

Underwriters of the recent issue of British Aluminium new Debenture had to take up 90 per cent. of their obligations, and the price has fallen to about 2½ discount. There are not many anxious buyers about either. Crompton's kept steady, the diminution in profit indicated in the recent report not affecting the quotations. British Insulated Preference rose ½, and the Debenture stock put on 2 points. General Electric Debenture has fallen 3. India-Rubber shares and Telegraph Constructions are both *ex* dividend, but the quotations remain unaltered.

Melbourne Tramway and Omnibus Co., Ltd.—A bonus at the rate of 5 per cent. has been declared for the year ended June 30th last.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years. 1904.	1905.	1906.	1907.	Closing Quotations July 14th.	Closing Quotations July 21st.	Business done week ended July 21st, 1908. Highest.	Lowest.	Rise + or Fall —	Present Yield per cent. £ s. d.
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	Nil	2 — 3	2 — 3	..	..	..	Nil
143,300	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	5 %	5 %	5 %	86 — 89	86 — 89	..	..	..	5 12 4
$131,551,400	American Telephone & Telegraph, Cap. Stock ..	$100	7¼%	7¼%	8 %	8 %	120 —124	119 —123 xd	..	..	—1	6 10 1
53,000,000	Do. Collat. Trust, 4% Bonds, 1 to 28,000 and 53,001 to 78,000	$1000	4 %	4 %	4 %	4 %	89 — 92	89 — 92	91	90½	..	4 7 0
598,180	Anglo-American Telegraph	Stock	2⅜%	3½%	3⅞%	3½%	58 — 61	57 — 60	57	..	—1	5 16 8
3,200,910	Do. do. do. 6 % Pref.	Stock	5⅜%	6 %	6 %	6 %	102 —103	103 —104	103⅜	103	+1	5 15 5
3,200,910	Do. do. do. Deferred	Stock	Nil	⅜%	1⅝%	1 %	15⅜— 16½	15⅜— 16½	16⅛	15⅜	..	5 3 1
50,000	Anglo-Portuguese Tel., 5 % Mort. Deb. Stock Red.	100	..	5 %	5 %	5 %	99 —102	100 —103	..	..	+1	4 17 1
44,000	Chili Telephone, Nos. 1 to 44,000	5	8 %	8 %	8 %	..	7⅜— 8	7⅜— 8½	..	..	+ ¼	5 0 0
2,883,376	Commercial Cable Sting. 500 year 4 % Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	83 — 86	83 — 86	85½	83½	..	4 17 0
16,000	Cuba Telegraph	10	5 %	5 %	5 %	..	7⅛— 8½	7⅛— 8½	..	..	..	5 17 8
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	10 %	15½— 16½	15⅛— 16½	..	..	—⅛	6 1 8
12,931	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	8 — 8½	8 — 9	60/-	..	..	6 3 1
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	8 — 9	8 — 9	..	..	..	5 11 1
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	100—103	100 —103	100	..	..	8 14 10
60,710	Direct United States Cable	20	3½%	4½%	4½%	4½%	13⅜— 14	13⅜— 13⅞	13⅛	13⅛	— ⅛	7 3 0
50,900	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	4½%	98 —100	98 —100	..	..	..	4 10 0
4,000,000	Eastern Telegraph, Ord. Stock..	Stock	7 %	7 %	7 %	7 %	133 —136	132 —135 xd	134½	132½	—1	5 3 8
2,000,000	Do. 3½ % Pref. Stock..	100	3½%	3½%	3½%	3½%	84½— 86½	83½— 85½	85	83½	—1	4 1 10
1,896,706	Do. 4 % Mort. Deb. Stock. Red....	Stock	4 %	4 %	4 %	4 %	101 —103	101 —103	103½	101½	..	3 17 8
800,000	Eastern Extension, Australasia, and China Tele.	10	7 %	7 %	7 %	7 %	12⅜— 12⅝	12⅜— 13½ xd	13½	12⅜	..	5 5 8
752,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	100½—102½	101 —103	102½	101½	+ ½	3 17 8
269,700	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..	3 18 5
200,000	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..	3 18 5
181,127	Globe Telegraph and Trust	10	5⅝%	5⅝%	5⅝%	5⅝%	10½— 11	10½— 10⅝	10⅝	10½	— ⅛	5 11 2
181,127	Do. do. 6 % Pref...	10	6 %	6 %	6 %	6 %	13⅜— 14½	13⅜— 13⅝	13½	13⅜	— ⅛	4 6 6
150,000	Great Northern Telegraph, of Copenhagen.. ..	10	24 %	24%	20 %	20 %	27 — 29	27 — 29	..	..	..	6 17 11
19,600	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	4½%	4½%	4½%	4½%	98 —100	98 —100	..	..	..	4 10 0
17,000	Indo-European Telegraph	25	13 %	13 %	13 %	13 %	55 — 58	56 — 59	58	..	+1	5 10 2
$41,380,400	Mackay Companies Common	$100	1 %	2 %	3½%	4 %	64 — 68	66 — 70	..	..	+2	5 14 4
$50,000,000	Do. do. 4% Cum. Pref.	$100	4 %	4 %	4 %	4 %	64 — 68	66 — 70	67½	..	+2	5 14 4
384,190	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	5/16— 5/16	5/16— 5/16	9/3	..	..	Nil
72,680	Monte Video Telephone Co., Ltd. Ord.	1	4 %	5 %	6 %	6 %	1 1/16— 1 1/8	1 1/16— 1 1/8	20/-	19/6	..	4 14 1
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	5 %	1 3/16— 1 5/16	1 3/16— 1 5/16	17/6	..	..	5 6 8
2,225,000	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	109 — 111	110 —112	111¼	110	+1	5 7 2
3,725,000	Do. do. Def. Stock	100	5 %	5 %	5 %	6 %	115½—117½	120½—122½	122	116	+5	4 18 0
15,000	Do. do. 6 % Cum. 1st. Pref.	10	6 %	6 %	6 %	6 %	10½— 12⅜	10½— 12⅜	..	..	..	4 16 0
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	5 %	5 %	10½— 12⅜	10 — 12	..	..	— ⅛	4 3 4
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5⅝— 5⅞	5⅝— 5⅞	5⅝	5⅝	— ⅛	4 8 11
2,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	98 —100	97½— 99½	99⅜	97⅛	— ⅛	3 10 4
1,716,598	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	100½—102½	100½—102½	101½	..	..	3 18 1
179,313	Oriental Telep. and Elec. 1 to 171,504, fully paid ..	1	6⅝%	7 %	7 %	8 %	1 1/16— 1 1/8	1 1/16— 1 1/8	..	..	..	6 1 11
50,000	Do. do. do. 6 % Cum. Pref.... ..	1	6 %	6 %	6 %	6 %	1⅛— 1⅛	1⅛— 1⅛	..	..	..	4 16 0
99,100	Do. do. do. 4 % Red. Deb. Stock ..	100	..	4 %	4 %	4 %	88 — 91	88 — 91	..	..	..	4 7 11
99,400	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	10	4 %	4 %	4 %	4 %	97 —100	97 —100	..	..	..	4 0 0
11,889	Reuter's	8	5 %	5 %	5 %	5 %	7⅞— 8½	7⅞— 8½	..	..	..	4 14 1
99,100	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	4½%	4½%	4½%	98 —101	98 —101	..	..	..	4 9 1
3,083	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	127 —130	127 —130	127½	127	..	4 13 4
100,000	United River Plate Telephone	5	8 %	8 %	8 %	8 %	6½— 7	6⅞— 7⅛	6⅞	6⅞	+ ⅛	5 10 4
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5 — 5¼	5 — 5⅛	..	..	..	4 15 8
30,008	W. Coast of America, 1 to 80,000 & 58,001 to 58,008	2	Nil	Nil	2½%	..	1 1/16— 1 1/8	1 1/16— 1 1/8	..	..	..	3 10 2
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..	3 19 3
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980.. ..	10	7 %	7 %	7 %	..	13½— 14	13⅝— 14⅛	14	13⅞	+ ⅛	4 19 1
800,000	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	99⅛—101⅛	99⅛—101⅛	..	..	..	3 18 10
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	Nil	⅜— ⅝	⅜— ⅝	12/6	..	..	Nil
84,563	Do. do. 6 % Cum. 1st Pref.	10	6 %	5 %	8 %	6 %	8 — 8½	8 — 8½	8⅝	8⅛	..	7 1 2
4,669	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	£2 6 0	8½— 9½	8½— 9½	9	..	..	2 9 0
80,000	D do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	99 —102	99 —102	..	..	..	4 18 0

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

320,000	Anglo-Argentine Trams, 10 % Nom. Cum. 2nd Pref., 260,008 to 580,097	5	8 %	8 %	8 %	9 %	8 7/16— 8 11/16	8 3/16— 8 11/16	8⅜	8⅛	+ ⅛	5 3 7
260,007	Do. 6 % Cum. Prefs., 1 to 260,007 ..	5	5⅛%	5⅛%	5⅛%	5⅛%	6½— 6⅝	6 1/16— 6 1/16	6⅜	6⅛	— 1/16	4 11 1
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	6 %	6 %	6 %	6 %	139 —144	139 —144	141	..	..	4 3 4
285,100	Auckland E. Trams, 5 % 1st Mort. Deb. Stock ..	100	5 %	5 %	5 %	5 %	103 —106	103 —106	..	..	..	4 14 4
880,000	Babcock & Wilcox, 1 to 530,000..	1	20 %	20 %	20 %	20 %	3 13/16— 4 1/16	3 13/16— 3 15/16	78/6	75/-	— ⅛	5 1 11
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	6 %	6 %	6 %	6 %	1 1/16— 1 1/8	1 1/16— 1 1/8	..	..	..	3 16 10
40,000	British Aluminium, Ord., 1 to 40,000	5	7 %	7 %	7 %	7 %	2⅜— 3⅛	2⅜— 3⅛	63/9	55/7½	..	10 15 4
40,000	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	4 — 4½	3⅜— 4⅛	83/9	80/-	— ⅛	7 17 9
20,000	Do. do. "A" 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	4⅜— 5⅛	4⅜— 5	92/6	..	— ⅛	6 0 0
20,000	Do. do. 4 % Funding Certs.	5	4 %	4 %	4 %	4 %	3⅞— 4⅛	3⅞— 4⅛	..	..	..	4 14 1
288,200	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	106 —110	106 —110	..	..	..	4 10 11
800,000	Do. do. 5% % Loch Leven Debs. ..	100	..	..	5⅛%	5⅛%	99 —102	99 —102	..	..	..	5 7 10
400,000	British Columbia E. Rail Def. Ord. Stock	100	6 %	6 %	6 %	8 %	124 —129	124 —129	124¼	..	..	6 4 0
800,000	Do. 5 % Pref. Ord. Stock	100	5 %	5 %	5 %	5 %	108 —112	108 —112	110½	109½	..	4 9 3
800,000	Do. 5 % Cum. Perp. Pref. Stock	100	5 %	5 %	5 %	5 %	107 —111	104 —108 xd	..	..	— 3	4 12 7
233,000	Do. 4½ % 1st Mort. Debs., 1 to 6,250	40	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..	4 8 8
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	4½%	4½%	4½%	4½%	101 —104	100 —103 xd	..	..	— 1	4 7 5
138,301	British Electric Traction	10	6 %	3 %	Nil	Nil	1⅜— 1⅞	1⅜— 1⅞	32/6	31/3	..	Nil
161,497	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	3 %	4½— 4¾	4½— 4¾	88/9	..	..	6 6 4
1,473,653	Do. do. 5 % Perp. Deb. Stock ..	Stock	5 %	5 %	5 %	5 %	95 — 98	95 — 98	97½	96½	..	5 2 0
528,936	Do. do. 4½ % 2nd Deb. Stock Red.	100	4½%	4½%	4½%	4½%	76 — 78	76 — 78	..	..	..	5 14 8
100,000	British Insulated and Helsby Cables	5	8 %	8 %	10 %	..	6 — 6½	6½— 6⅝	..	..	+ ⅛	7 8 2
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	6 — 6½	6 — 6½	..	..	..	4 16 0
500,000	Do. do. 4½ % 1st Mort. Deb. Red. ..	100	4½%	4½%	4½%	4½%	100 —103	102 —105	..	..	+2	4 5 9
212,000	British Thomson-Houston 4½ % 1st Mort. Debs.	100	4½%	4½%	4½%	4½%	93 — 98	93 — 98	..	..	..	4 11 10
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	Nil	Nil	Nil	Nil	7/16— 1/2	7/16— 1/2	..	..	..	Nil
1,016,358	Do. do. 4 % Mort. Deb. Stock ..	100	4 %	4 %	4 %	4 %	43 — 48	43 — 48	..	..	..	8 6 8
50,000	‡Browett, Lindley & Co., Ord.	1	Nil	Nil	Nil	Nil	3/16— 1/4	3/16— 1/4	..	..	..	Nil
50,000	‡ Do. do. 6 % Cum. Pref.	1	Nil	Nil	Nil	Nil	14/6 to 15/6	14/6 to 15/6	..	..	..	Nil
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	2½%	Nil	Nil	0— 1/4	0 — 1/4	..	..	..	Nil
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	6 %	Nil	Nil	1/16— 1/8	1/16— 1/8	..	..	..	Nil
125,000	Do. do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	4½%	70 — 75	70 — 75	..	..	..	6 0 0
125,000	Do. do. 4½ % Perp. 2nd Deb. Stock..	Stock	4½%	4½%	4½%	4½%	53 — 58	53 — 58	..	..	..	7 15 2
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	4 %	3 %	3 %	..	..	..	..	..	..	3 1 6
40,000	Do. do. "A" 6 % Cum. Pref., 1 to 40,000	5	6 %	6 %	6 %	6 %	..	..	..	..	..	5 17 1
27,500	Do. do. "B" do., 1 to 27,500	5	6 %	6 %	6 %	6 %	..	..	..	..	..	5 17 1
136,400	Do. do. 5 % Deb. Stock	100	5 %	5 %	5 %	5 %	..	..	..	..	..	4 6 2
190,000	Do. do. 5 % 2nd Deb. Stock	100	5 %	5 %	5 %	5 %	..	..	..	..	..	4 15 8
137,510	Calcutta Trams, 1 to 137,510	5	8 %	8 %	8 %	6 %	5¼— 6	5¼— 6	5 11/16	..	..	5 0 0
80,000	Do. 5 % Cum. Pref., Nos. 1 to 29,330..	5	..	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	5 1/16	..	..	4 13 0
850,000	Do. do. 4½ % 1st Deb. Stock..	100	4½%	4½%	4½%	4½%	101 —104	101 —104	..	..	..	4 6 7
85,000	Callender's Cable Construction shares	5	12½%	15 %	15 %	15 %	9½— 10½	9½— 10½	..	..	..	7 2 10
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5¼— 5½	5¼— 5½	..	..	..	4 5 11
800,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	105 —107	104½—106½	105	..	— ⅛	4 4 6
491,228	Cape El Trams., 1 to 491,222	1	5 %	Nil	Nil	Nil	7/16— 7/16	7/16— 7/16	3/9	..	..	Nil
450,000	Castner-Kellner Alkali, 1 to 450,000	1	4 %	6 %	8 %	12 %	1 5/16— 1 7/16	1 5/16— 1 7/16	27/6	..	..	8 7 0
215,045	Do. do. 4½ % 1st Mort. Deb. Stock	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..	4 5 9
1,893,610	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	3 %	72 — 75	68 — 71	72	69	—4	4 4 6
553,195	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %	88 — 90	88 — 90	..	..	..	4 8 11
553,195	Do. do. Def. do.	Stock	4 %	4 %	4 %	2 %	54 — 57	53 — 56	55	53	—1	3 11 0
1,490,000	City and South London Railway	Stock	2⅛%	1⅞%	2⅛%	2⅛%	35 — 37	33½— 34½	35	33	—2	6 3 2

Unless otherwise stated, all shares are fully paid. † A period of nine months. ‡ From Manchester Share List.

Continued on next page

SHARE LIST OF ELECTRICAL COMPANIES.—(*Continued.*)

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—(*Continued*)

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations July 14th.	Closing Quotations July 21st.	Business done week ended July 21st, 1908.		Rise + or Fall —	Present Yield per cent.
		*	1904.	1905.	1906.	1907.			Highest	Lowest.		£ s. d
85,000	Crompton & Co., Nos. 1 to 85,000	S	2½%	2½%	5 %	5 %	1⅞ — 1⅞	1⅞ — 1⅞	34/4½	..	..	8 0 0
100,000§	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red.	..	5 %	5 %	5 %	5 %	90 — 93	90 — 93	..	..	..	5 5 11
260,000	Dick, Kerr & Co., 1 to 260,000	1	10 %	10 %	10 %	10 %	1½ — 1⅝	1½ — 1⅝	..	..	..	7 5 5
805,000	Do. do. 6 % Cum. Pref., 1 to 805,000	1	6 %	6 %	6 %	6 %	1 — 1¼	1 — 1¼	..	..	..	4 16 0
232,580	Do. do. 4½ % Deb. Stock	100	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..	4 8 3
60,000	Dublin United Trams. (1896), 1 to 60,000	10	6 %	6%	6 %	6¾%	12⅝— 13⅛	12⅝— 13⅛	..	..	..	4 18 2
59,987	Do. 6 % Pref. between 1 and 60,000	10	6 %	6 %	6 %	6 %	12⅝— 13⅜	12⅝— 13⅜	..	..	..	4 7 3
99,261	Edison & Swan Utd., "A" shs., £3 pd., 1 to 99,261	5	2½%	4½%	4½%	4½%	⅜ — ½	⅜ — ½	..	..	..	16 15 0
17,139	Do. "A" shares, 01—017,139	5	2½%	4½%	4½%	4½%	1¼ — 2⅜	1¼ — 2⅜	36/3	..	..	8 6 9
319,475	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	76 — 79	76 — 79	..	..	..	5 1 3
72,220	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	85 — 87	85 — 87	..	..	..	5 14 11
112,100	Electric Construction, 1 to 112,100	2	4 %	Nil	Nil	Nil	⅛ — ¼	⅛ — ¼	..	..	..	Nil
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	7 %	7 %	7 %	Nil	1½ — 2	1½ — 2	35/7½	..	..	Nil
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	5 %	7⅛ — 8	7⅛ — 8	..	..	..	6 5 0
200,000	Do. do 4 % Mort Deb.	Stock	4 %	4 %	4 %	4 %	87 — 90	84 — 87	85½	..	—3	4 12 0
78,000	Gt. N. & City Rail. Pref. Ord. "A" 4 %, 1 to 78,000	10	4 %	4 %	4 %	¾%	⅜ — 1½	⅜ — 1½	..	..	..	3 6 8
96,000	Greenwood & Batley, 7 % Cum. Pref.	10	7 %	7 %	7 %	..	10½ — 10¾	10½ — 10¾	..	..	..	6 10 8
80,000	Do. do. 5 % Mort. Debs.	100	5 %	5 %	5 %	..	102 —103	102 —103	..	..	..	4 17 1
40,000	Henley's (W. T.), Telegraph Works, Ord.	5	15 %	15%	15 %	15%	10½ — 11½	10⅝ — 11⅝	..	..	..	8 18 10
40,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5 — 5½	5 — 5½	5⅛	..	..	4 1 10
150,000	Do. do. 4½ % Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	105 — 107	106 — 108	..	..	+1	4 3 4
50,000	India-Rubber, Gutta-percha & Telegraph Works.	10	5 %	10%	10 %	..	15½ — 16½	15⅝ — 16½	15⅛	..	..	6 1 8
37,500	†Liverpool Overhead Railway, Ord.	10	1½	Nil	Nil	¾%	1½ — 1⅝	1½ — 1⅝	..	..	..	3 14 1
10,000	† Do. do. Pref., fully paid	10	5 %	5 %	5 %	5 %	5½ — 6½	5½ — 6½	..	..	..	8 0 0
600,070	London United Trams. (1901), 1 to 50,007	10	6 %	3 %	3 %	..	6½ — 6¾	6½ — 6¾	..	..	..	4 8 11
399,930	Do. do. 60,008 to 100,000	10	6 %	3 %	3 %	..	6½ — 6¾	6½ — 6¾	..	..	..	4 8 11
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	5 %	5 %	5 %	5 %	7 — 8	7 — 8	..	..	..	6 5 0
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	4 %	4 %	4 %	4 %	79 — 84	79 — 84	79⅜	..	..	4 15 3
5,782,062	Metropolitan Consolidated	100	3 %	23%	1 %	¾%	36½ — 37½	34½ — 35½	37 1/16	34½	—2	1 8 2
2,640,914	Do. Surplus Lands	100	25%	25%	23%	2¾%	68 — 70	67 — 69	69½	68	—1	3 19 9
3,235,000	Do. District	100	Nil	Nil	Nil	Nil	11¾ — 12½	11 — 12	12½	11⅝	— ⅜	Nil
314,016	Metropolitan Electric Trams., Defd.	1	Nil	Nil	Nil	..	3/32 — 5/32	3/32 — 5/32	..	..	..	Nil
500,000	Do. do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	5/32 — 7/32	5/32 — 7/32	15/-	13/9	..	6 3 1
350,000	Do. do. 4½ % Deb. Stock Red.	100	4½%	4½%	4½%	4½%	93 — 96	93 — 96	93¾	..	..	4 13 9
245,500	Potteries E. Trc.	1	5 %	4 %	4 %	4 %	⅛ — ¼	⅛ — ¼	..	..	..	8 0 0
245,500	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	⅛ — ¼	⅛ — ¼	..	..	..	6 13 4
245,000	Do. 4½ % Deb. Stock	100	4½%	4½%	4½%	4½%	93 — 96	93 — 96	..	..	..	4 18 9
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	17½%	31 — 33	31 — 33	31½	31	..	6 5 0
150,000§	Do. 4 % Deb. Bds., 1 to 1,500 Red., 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..	3 18 5
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	5 %	5 %	5 %	5 %	40 — 44	40 — 44	..	..	..	11 7 4
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	1	Nil	Nil	Nil	10 %	⅜ — 1½	⅜ — 1½	..	..	..	8 0 0
66,666	Do. 6 % C.P., 30,001 to 80,000 & 125,001 to 141,666	5	Nil	Nil	..	6 %	3½ — 3¾	3½ — 3¾	70/-	65/-	..	9 4 7
46,404	Do. 4 % 1st Mort. Deb. Stock	100	4 %	4 %	4 %	4 %	72 — 76	72 — 76	..	..	..	5 5 3

ELECTRICITY SUPPLY COMPANIES.

15,000	Bromley (Kent) E.L. & P., 1 to 15,000	5	5½%	5½%	5½%	5⅝%	4½— 5	4½— 5	..	..	..	5 10 0
70,000	Do. do. 4½ % 1st. deb. stock	100	4½%	4½%	4½%	4½%	94 — 97	94 — 97	..	..	..	4 10 11
30,131	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 20,000	5	10 %	10 %	10%	10 %	7 — 8	7 — 8	..	..	..	6 5 0
9,869	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	6¾— 7¾	6¾— 7¾	..	..	..	4 10 4
836,876	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	98 —101	98 — 101	..	..	..	3 19 3
80,000	Charing Cross and Strand Electricity Supply	5	8 %	5 %	5 %	5 %	3⅝— 4¼	3⅝— 4¼	..	..	..	5 17 8
80,000	Do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4 — 4⅜	4 — 4⅜	..	..	..	5 0 0
80,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	3⅝— 4⅛	3⅝— 4⅛	..	..	..	4 17 4
445,736	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	94 — 97	94 — 97	96	95	..	4 2 6
49,436	Chelsea Electricity Supply, Ord.	5	6 %	6 %	4½%	4½%	3 — 3½	3 — 3½	65/-	60/7½	..	6 8 7
175,000§	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	100 —103	100 —103	..	..	..	4 7 5
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	6 %	6 %	6 %	6 %	9½ — 10⅜	9½ — 10⅜	9⅞	9¼	..	5 14 3
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	12 — 13	12 — 13	..	..	..	4 12 4
400,000§	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	122 —125	122 —125	..	..	..	4 0 0
800,000	Do. 4½ % 2nd. Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	101 —104	101 —104	..	..	..	4 6 7
40,000	County of Durham Electrical Power, Ord.	5	£3 7 0	4 %	4 %	2 %	2½ — 3	2½ — 3	..	..	..	3 6 8
50,000	Do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	3½ — 4¼	3½ — 4¼	..	..	..	5 17 8
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4½%	5 %	5 %	5 %	7⅜ — 8¼	7⅜ — 8¼	7⅜	..	..	6 1 3
40,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	10⅜ — 10¾	10½ — 11	10¾	10½	+ ⅛	5 9 1
400,000§	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	105 —108	106 —109	107⅛	..	+1	4 2 7
400,000	Do. do. 4½ % 2nd. Deb. Stock	Stock	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..	4 9 1
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	4 %	Nil	Nil	⅛ — ⅜	⅛ — ⅜	..	..	..	Nil
80,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	3 %	Nil	½ — 1	½ — 1	..	..	..	Nil
433,000	Do. do. 4½ % 1st Mort. Deb. Stk.	100	4½%	4½%	4½%	4½%	63 — 73	61 — 71	..	..	—2	6 6 9
10,000	Folkestone, 1 to 10,000	5	5½%	5½%	5½%	5½%	4⅜— 5½	4⅜— 5½	..	..	..	5 4 9
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	5 %	5 %	5 %	5 — 5½	5 — 5½	..	..	..	4 10 11
90,000	Do. 4½ % 1st Deb. Stock	100	4½%	4½%	4½%	4½%	97 —100	98 —101	..	..	+1	4 9 1
15,000	Hove, 1 to 13,000	5	8½%	9 %	9 %	8½%	6 — 6½	6 — 6½	6 1/16	..	..	6 10 9
21,000	Kensington and Knightsbridge Electric Ord.	5	12 %	10 %	10 %	10 %	8 — 9	8 — 9	..	..	..	5 9 7
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	96 — 99	96 — 99	..	..	..	4 0 10
10,000	London Electric Supply Corporation, Limited, Ord.	3	3 %	4 %	4 %	2½%	⅞ — 1⅜	⅞ — 1⅜	26/3	..	..	5 8 1
70,000	Do. do. do 6 % Pref.	5	6 %	6 %	6 %	6 %	4½ — 5	4½ — 5	..	..	..	6 0 0
74,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4½%	89 — 92	89 — 92	..	..	..	4 17 10
200,000	Metropolitan Electric Supply, 1 to 100,000	5	10 %	10 %	8 %	6½%	4⅝— 5⅛	4⅝— 5⅛	..	..	..	5 15 7
76,121	Do. 4½ % Cum. Pref. 1—71,106	5	4½%	4½%	4½%	4½%	4⅝— 4¾	4⅝— 4⅞	98/9	..	..	4 12 4
220,000§	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	105 —109	105 —109	105⅛	..	..	4 2 7
250,000§	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	84 — 89	84 — 89	..	..	..	3 18 8
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	94 — 97	94 — 97	..	..	..	4 12 9
87,500	Newcastle-on-Tyne, 1 to 87,500	5	8 %	8 %	8 %	8 %	5½ — 6	5⅝ — 5⅞ xd	..	..	— ⅛	6 14 9
87,500	Do. 5 % Pref., 1 to 87,500	5	5 %	5 %	5 %	5 %	5½ — 5⅝	5⅝ — 5⅝ xd	..	..	— ⅛	4 13 0
10,852	Notting Hill Electric Lighting	10	7 %	7½%	7½%	7½%	12 — 13	12 — 13	..	..	..	5 15 5
20,000	Oxford, 1 to 96 and 407 to 20,810	5	7 %	7 %	7 %	7 %	5⅝ — 6¼	5⅝ — 6¼	..	..	..	5 12 0
50,000	Do. 4 % Deb. Stock	100	4 %	4 %	4 %	4 %	96 — 99	95 — 99	..	..	..	4 0 10
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	12½%	10 %	10 %	7½ — 8¾	7⅝ — 8½	..	..	..	5 17 8
20,000	Do. do. 7 % Pref. 20,081 to 40,080	5	7 %	7 %	7 %	7 %	6¾ — 7¼	6¾ — 7¼	6⅔	..	..	4 16 7
50,000§	Do. do. 3½ % Deb. Stock Red.	100	3½%	3 %	3½%	3½%	86 — 90	86 — 90	..	..	..	3 17 9
12,000	Smithfield Markets Electric Supply, Ord.	5	4 %	4 %	Nil	Nil	⅛ — ¼	⅛ — ¼	..	..	..	Nil
80,000	Do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	70 — 74	70 — 74	..	..	..	5 8 1
65,000	South London Electricity Supply, Ord.	5	4 %	4 %	3 %	4 %	2⅜— 2⅞	2⅜— 2⅞	..	..	..	6 19 2
20,000	South Met. Elec. Lt. & Power, Ord.	1	Nil	2½%	2½%	2½%	⅜ — ½	⅜ — ½	..	..	..	3 6 8
117,968	Do. do. 7 % Pref.	1	7 %	7 %	7 %	7 %	1 — 1½	1 — 1½	..	..	..	5 12 0
200,000	Do. do. 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	99 —102	99 —102	..	..	..	4 8 3
80,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	1 — 2	½ — 1½	..	..	— ½	16 13
50,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	1½ — 2⅝	1½ — 2⅝	37/6	..	..	10 10 6
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red.	100	4½%	4½%	4½%	4½%	87 — 90	82 — 85	..	..	—5	5 5 11
110,000	Westminster Electric Supply, Ord.	5	14 %	18 %	12 %	10 %	7⅜ — 8⅜	7⅜ — 8⅜	8 1/16	8½	..	5 14 3
81,279	Do. do. 4½ % Cum. Pref. (Original 5 %—Red. to 4½ % from 31st Dec., 1906)	5	5 %	5 %	4½%	4½%	4⅛ — 5⅛	4⅛ — 5⅛	..	..	..	4 5 9

* Unless otherwise stated, all shares are fully paid. † Quotations on Liverpool Stock Exchange. § Interim Dividend.

Bank rate of Discount 2½ per cent. May 28th, 1908.

THE COLLIERY EXHIBITION.

(*Continued from page* 88.)

Messrs. Reavell & Co., Ltd., of Ipswich, exhibit several of their high-speed air compressors, all electrically driven, and suitable for use "in-bye" at collieries for driving coal-cutters at the face. Among the exhibits is the small sub-station cleaning set for blowing dust out of armatures, &c., which we noticed some little time ago. This firm also shows a small high-speed, double-acting, enclosed-type steam engine, with throttle-valve governor, suitable for a small lighting set.

Messrs. Jos. Wright & Co., Tipton, exhibit a "Multiplex" water heating and softening plant, with the soda tank and automatic chemical apparatus on top of the heater. They may, however, be arranged in a variety of ways to suit the space to be occupied. The firm guarantees with this apparatus to heat water to a temperature of from 205° F. to 210° F., and absolutely to eliminate grease.

Messrs. The International Channelling Machines, Ltd., Sheffield, exhibit a new electrically-driven compound air-compressor, the chief feature of which lies in the construction of the valves, which consist of plain cylindrical steel tubes, with a new overload device.

Messrs. Clarke, Stevenson & Co., Ltd., of Barnsley, to whom credit is due for first applying electricity to drive a longwall coal-cutting machine, exhibit their latest improved coal-cutter, which is shown in fig. 3. This machine may be driven by either a direct-current or a three-phase motor, and will work in a total height of 18 in. or 22 in.; it may be arranged to under-cut to a depth of 3 ft. 6 in., 4 ft. 6 in. or 5 ft. 4 in., and, as will be seen, works on skids. The

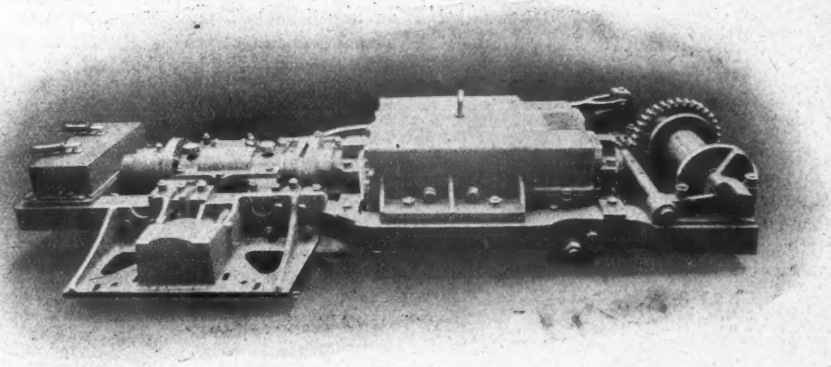

Fig. 3.—Clarke-Stevenson Worm-Gear Coal-Cutter.

special feature of the machine is in the worm drive, which reduces the noise when working, thus minimising the risk when working under a bad roof, and enabling the workmen to carry on a conversation easily when the machine is running. The worm gearing consists of a steel worm and phosphor-bronze worm wheel running in oil, and the thrust is taken up by ball bearings of massive design.

of ball bearings and inclined working faces, in place of the supporting legs of the "Zimmer." The conveyors are made in sections, and are driven by means of eccentrics—also

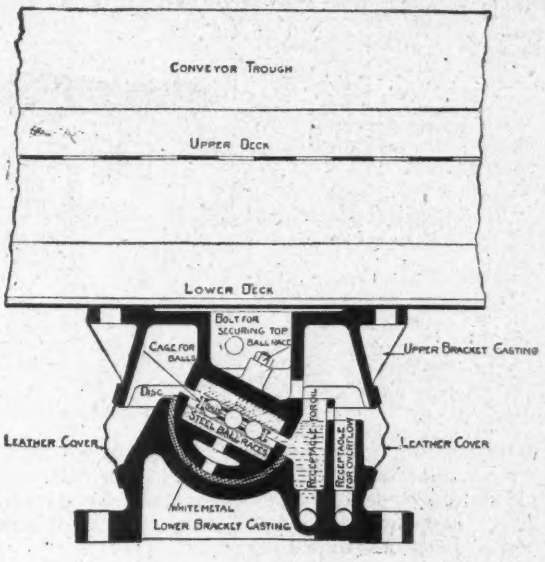

Fig. 5.

provided with ball bearings—so that each length works in the opposite direction to the other. Fig. 4 shows the arrangement and the driving eccentrics, and the method of enclosing the latter, while fig. 5 is a section through the conveyor and ball bearings. This shows that the conveyor trough is divided into two decks, the upper one being fitted with a perforated plate for sizing the coal or other material being conveyed. The lower ball race is fitted to a spherical bearing, which allows the two faces automatically to adjust themselves to each other, and the two brackets are covered with leather to keep the bearings as dust-proof as possible. As the screen rapidly reciprocates, it imparts energy to the particles of material lying in the trough. Thus, on the forward motion the material is thrown upwards and forward, and as the screen recedes, it falls again on the plate into a new position a little in advance of that previously occupied;

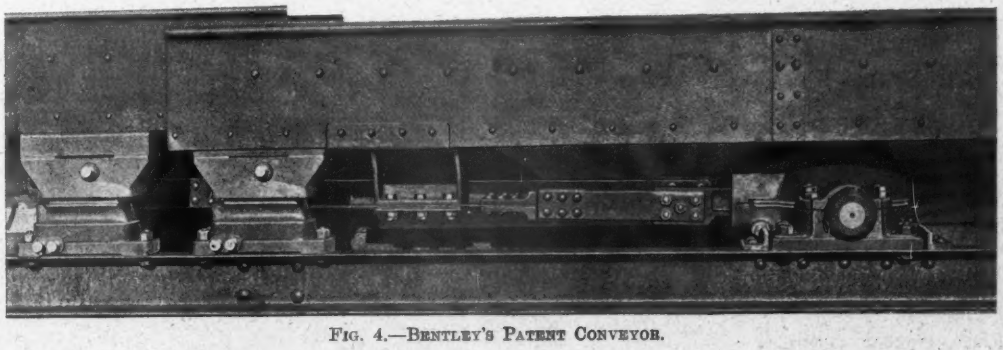

Fig. 4.—Bentley's Patent Conveyor.

Messrs. The New Lowca Engineering Co., Ltd., Whitehaven, exhibit Bentley's patent screen conveyors. This conveyor is of a similar class to the well-known "Kreiss" or "Zimmer," in which the material is moved along by a hopping motion. The improvement lies in the application this action is quickly repeated until the end of the conveyor is reached. The only advantage of the machine lies, of course, in the reduced friction of the sliding surfaces, due to the ball bearings, and the consequent reduction of power required for driving, and it retains all the disad-

vantages of grinding soft and friable material, which are practically inseparable from this type of conveyor. In view, however, of the increasing desire to drive this class of machinery by small independent electro-motors, the former advantage is important, and as an example of the small power required, it may be stated that in the case of the screen on the stand, which is 20 ft. long × 2 ft. wide, and capable of dealing with 20 tons of coal per hour, though it is driven by a 5-H.P. motor, the actual power consumed does not exceed 1 H.P.

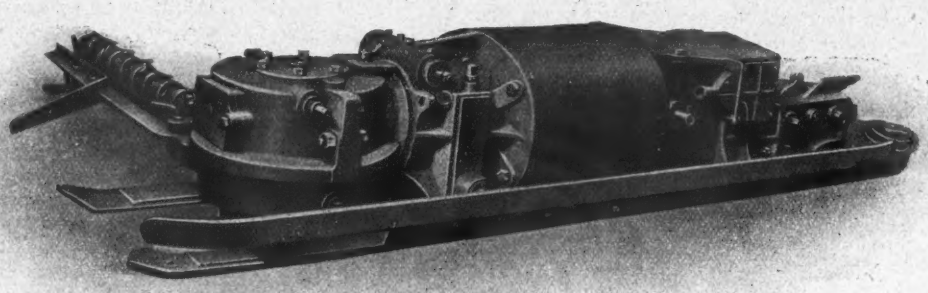

Fig. 6.—Mavor & Coulson Three-Phase Medium Size Coal-Cutter.

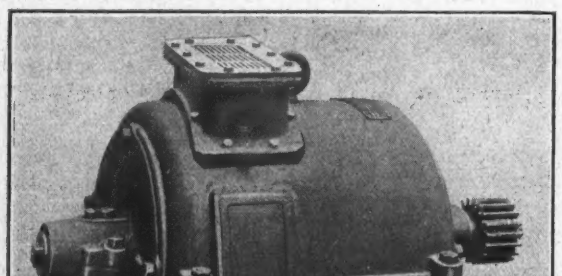

Fig. 7.—Safety Motor.

Messrs. Mavor & Coulson, Ltd., 147, Broad Street, Mile End, Glasgow, exhibit several of their "Pick-Quick" coal-cutters, one of which is shown in fig. 6. This represents a medium size machine, 23½ in. in height, with three-phase motor and improved haulage gear, mounted upon skids. Another machine—which is claimed to be the smallest longwall coal-cutter yet produced—is of the direct-current type, with a total height of 15½ in. The cutter bar is 3 ft. 6 in. long. In the three-phase machines the rotor is of the squirrel-cage type, with a starting auto-transformer enclosed in a flame-tight cast-iron box. Another exhibit consists of a 27-B.H.P. safety motor, which is illustrated in fig. 7. As is well known, it is practically an impossibility to construct a motor that shall be gas-tight and to maintain it so, as no matter how carefully the cover and inspection door joints are made, and the passages for cable connections packed, gas cannot be excluded from the interior of the casing. Messrs. Mavor & Coulson, therefore, have turned their attention to designing a motor which, while being fully enclosed for protection from mechanical injury, will also be safe from injury due to slight explosions of gas which may occur in the interior. This is obtained by providing an opening on top of the casing, which is covered by a cast-iron box, as shown. This cover contains a series of diaphragms of safety lamp gauze, each diaphragm being separated from the next by an interspace. These diaphragms, which are protected from injury by strong grids, permit the release of any internal pressure due to the ignition of small quantities of gas, while the gauze prevents any possibility of the passage of flame. The cable connections of the motor are taken through sockets which are hermetically sealed by an imperishable damp-and-heat-resisting cement. A fully-enclosed starting switch is shown, in which the resistance coils are fitted inside cylindrical asbestos tubes, while the various flexible connections are covered with glass beads, a simple means of at once retaining their flexibility and providing mechanical protection. A set of their patent box-type brush gear is also shown.

Another exhibit of this firm is a new "face" coal conveyor. Owing to the largely increased outputs due to coal-cutters—from relatively short lengths of "face"—practically the only method of dealing economically and promptly with the coal is to load it on a conveyor running the length of the longwall face, which conveys it to the gateway and loads it direct into the tubs. The variety of conditions met with, however, have caused more or less difficulty in devising suitable apparatus, but the advantages to be derived from successful conveyors are so great that ingenuity will be further stimulated in this direction to obtain the desired result. The "Gibb" conveyor shown on this stand consists of a long, low, jointed carriage running on plain broad wheels, which, in addition to discharging the coal into tubs placed below the discharge end, by means of scrapers in the usual way, moves to and fro along the coal face. Fig. 8 shows the conveyor as seen from the coal face side, while fig. 9 illustrates a section through the seam to show the method of working. The carriage exhibited has a maximum height from the pavement of 19 in., and an inside width of 25 in. It consists

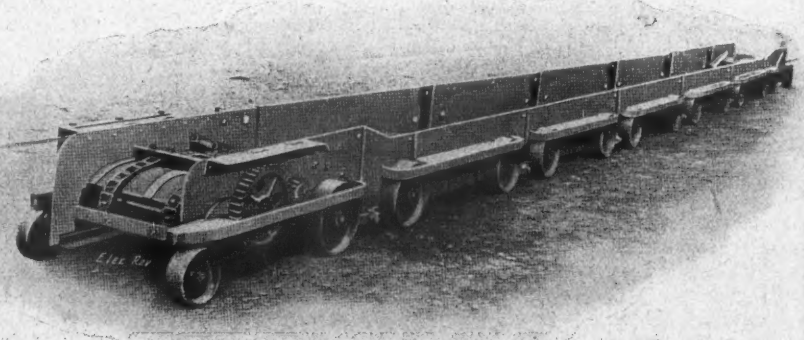

Fig. 8.—Mavor & Coulson Face Conveyor.

of the two end sections and five intermediate sections, each 6 ft. long. The end discharge is effected by angle-bar scrapers attached to a pair of endless chains, which are returned under the bottom of the carriage. The discharging end contains the gear by which these scraper chains are operated. The gear wheels are all of cast-steel, as are the cheeks carrying the shaft bearings, and the framework is substantially built of steel angles and sheets. The intermediate sections are also built of steel throughout, and are provided with wearing strips and guides for the scrapers. The back end is constructed similarly to the discharging end, but is only fitted with a sprocket wheel for returning the scraper chains, and a shaft which carries at one end a rope wheel and at the other end a ratchet. A rope is passed around this wheel, which is free to rotate

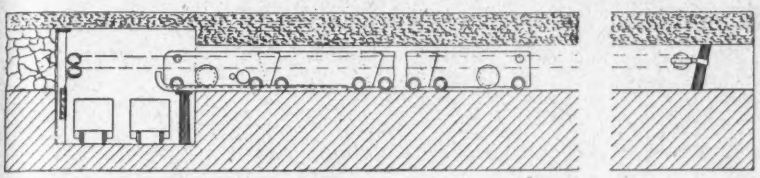

Fig. 9.—Section of Seam Showing Face Conveyor.

idly while the rope is operating the discharge, but when the direction of the rope is reversed, the ratchet fixes the wheel and the whole carriage is drawn along the face to the desired position. The motor for working the apparatus is placed on one side in the main gateway, and drives an endless rope haulage wheel through worm gearing, the rope being led by means of snatch blocks and guide pulleys into the required directions, and in order to move the carriage to and fro the motor is reversed. The carriage, therefore, after being filled is hauled along the face to the gateway until its end overhangs a coal tub, when its further progress is arrested by "stops," automatically operating a trigger, which disengages the discharging gear, thus setting the scrapers in motion. The controller of the motor is placed close to the discharging position, so that the rate of discharge may be regulated or stopped for the purpose of changing tubs. After the load is discharged the travel of the rope is reversed by operating the controller, the trigger re-engages and locks the discharging gear, and the carriage returns along the face to the fillers, who, in the meantime, have been breaking down and preparing coal for filling, and where dirt is present casting this back into the goaf. The arrangement is one which has many advantages to recommend it, such as absence of noise—as the machine is at rest while being filled, and moves quietly along the face, and warning sounds which precede a fall are audible to the men—portability and freedom from damage by falls of roof.

(*To be continued.*)

THE PETROL-ELECTRIC DRIVE AND OTHER MIXED SYSTEMS.

By FRANK BROADBENT, M.I.E.E.

Since Heilmann ran his experimental steam-electric locomotive on one of the French main-line railways, there has been but little attempt to follow up this somewhat radical departure in train propulsion. Few people were found at that time to believe in the advantages of carrying an electric generating station and complete power distribution equipment on the locomotive; for it will be remembered that Heilmann carried not only the generating plant on the locomotive, but also the electric motors themselves, which were geared up to the driving axles. As the experiment was carried out on a main-line express, the full advantages of such a system were not fully brought out, the principal claims for the system being the reduced wear and tear of the permanent way and the steadier running of the train. Had the experiment been tried on a suburban line, where frequent starting and stopping is necessary, the advantages of improved acceleration might have been demonstrated, more particularly if the driving power had been split up among the coaches on the lines of the multiple-unit system. Since the adoption of the modern form of internal combustion engine—that is to say, the petrol engine—for auto-car propulsion the Heilmann principle has been revived (although Heilmann's pioneer work is almost forgotten), and several petrol-electric cars have been tried on short lines of railway. The North-Eastern Railway Co., for instance, put down two petrol-electric cars on their Hartlepool branch line. These were equipped with 85-b.h.p. four-cylinder Wolseley engines running at 420 r.p.m., and direct coupled to 55-kw. compound-wound generators, the car being driven by two 50-h.p. motors. The system does not appear to have been extended, so that it might be inferred that the advantages anticipated for this method of working have not been fully realised. Several petrol-electric cars on somewhat similar lines are in satisfactory use on two of the Hungarian railways. The system has also been adopted on a small scale in several parts of America; in some cases the series-parallel method of control is used, and in others the control is obtained by a shunt regulator in the exciting circuit of the generator.

Some trial petrol-electric railway cars are now under construction for the London, Brighton and South Coast Railway. These will operate on the Pieper Auto-mixte system, and each car will be equipped with a 120-h.p. Daimler engine coupled to a dynamo, which can act also as a motor developing 50 b.h.p. A battery of 48 accumulators is provided, the cells of which are charged by the dynamo. When the full power of the engine is not needed for propelling the car when starting and accelerating or hill-climbing, the accumulators drive the motor which then assists the engine. The configuration of the line and the ratio of the number of stops to the running time must clearly play a not unimportant part in the successful running of such a system, and in the kind of life the battery leads. At the best, the lot of an automobile battery is not a happy one.

That the idea of driving trains by a mixed electro-mechanical system is not quite so mad as might at first sight appear to the mechanically-trained engineer, is shown by the comparative figures contained in the report recently prepared for the Hungarian Minister of Commerce (*vide Elektrotechnik u. Maschinenbau*, April 26th).

According to this report, the cost per car kilometre is as follows:—

Arader-Csanadar Railways.—*Fuel Costs.*

With a 40-h.p. Daimler petrol engine only	=	·933d.
„ 35-p.p. Ganz steam engine (wood)	=	·784d.
„ 30-h.p. Weiz petrol-electric set	=	·734d.

The maintenance costs per train-kilometre also show the petrol-electric system in a favourable light, thus—

Ordinary loco. and tender	1·18d.
Petrol 70-h.p. motor-coach	·488d.
Petrol-electric 70-h.p. ditto	·404d.
Steam ditto, 30-h.p.	1·15d.
„ 35-h.p.	·48d.
„ 50-h.p.	·548d.

One must not, of course, attach too much importance to comparative figures based on only one or two equipments, but there is quite sufficient justification in the above figures for the belief that, from commercial considerations alone, a mixed electro-mechanical system of driving is worth developing. Then the lessened wear and tear of the permanent way, the comfort of the passengers, and the increased acceleration which the electric drive gives, are all points which have a considerable market value.

Some figures relating to the motor-coaches on the Hungarian State Railways show the comparative costs between a 35-50 h.p. Ganz steam set, using coal, and a 70 h.p. Weiz petrol-electric set. The fuel costs are ·45d. for the steam and 1·12d. for the mixed drive.

This is favourable to the steam coach, but when we add the cost of oil and attendance, the total running costs are 1·97d. and 2·46d. respectively, a difference of about ½d. per

car km. When, however, we compare the total costs, including maintenance, the mixed system comes out the better owing to the very much lower maintenance costs. The full comparison is as follows :—

	Steam.	*Petrol-Electric.*
Fuel	0·45d.	1·127d.
Oil	0·15d.	0·270d.
Attendance	1·37d.	1·063d.
Running costs ...	1·97d.	2·460d.
Maintenance	1·15d.	0·404d.
Total costs	3·12d.	2·864d.

It should be pointed out, moreover, that the costs of the steam set are the average over 1,591,411 km., whilst the km. run by the petrol-electric set are only 135,048.

It will be interesting to see the comparative figures when the mileage is more nearly equal.

It is, however, in connection with road vehicles, and more particularly omnibus working, that attempts are now being made in this country to show the advantages of the petrol-electric drive. In an interesting paper recently read before the Society of Road Traction Engineers by Messrs. Percy Frost-Smith and W. A. Stevens, it was clearly shown that quite apart from the many obvious disadvantages of the ordinary petrol-driven 'bus there is another disadvantage, which will probably carry more weight than all the others, namely, the fact that these 'buses are commercially unprofitable. In the course of the paper the authors say that many of the smaller companies have "gone under," and the appalling financial losses made by the larger companies indicate the urgent need for a radical reform in the methods of working. The present high cost of operation is attributed to the abuse to which the vehicle can be subjected by reason of the bad driving and carelessness, which results in undue wear and tear of the clutch gear, and damage to gear boxes and transmission gear. It is stated that the present night staff necessary to prepare the mechanism for the following day's work, excluding washers, is 1·5 men per vehicle, and even then the object is not always achieved, that is to say, the 'buses are not always ready when required. The authors are of opinion that we must not look for any improvement in the type nor in the degree of intelligence of motor-'bus drivers, but that we must take the man as he exists, and design vehicles to suit him, rather than first of all designing vehicles, and then trying to find competent drivers to understand and work them. The present working costs of the motor-'buses run by Messrs. Tillings, the company which Mr. Frost-Smith represents, are practically 1s. per 'bus-mile, made up as follows :—

Day running	0·265d.
Night running	0·750d.
Maintenance	2·443d.
Lubricants	0·241d.
Grease	0·080d.
Paraffin	0·040d.
Vehicle lighting	0·105d.
Body upkeep	0·250d.
Drivers	1·308d.
Tires	1·750d.
Conductors	0·945d.
Petrol	1·325d.
Traffic expenses	0·255d.
Depreciation, insurance, rents, rates, taxes, water, gas, garage lighting, supervision and establishment charges	2·180d.
Total	11·937d.

The above figures represent the average over a period of three years, and clearly show the hopelessness of continuing on present lines. Apart from the expense of running these 'buses, there are the obvious disadvantages of noise, smell, the dropping of oil on to the roadway, and the danger to life and limb. Things have now come to such a pass that at a recent meeting of representative city business men, resolutions were passed condemning the present state of things, and calling upon the authorities to exercise proper control over street motor traction. Whilst it is recognised that it is futile to call for the abolition of motor traction altogether, it is maintained, and rightly so, that it should be conducted on such lines as shall not prove a nuisance to the public and hamper the conduct of business generally. It was pointed out, at the meeting referred to, that along the line of route it was quite impossible now, owing to the noise and smell of the vehicles, to work with the office windows open; and even with the windows closed, business was very seriously disturbed and interfered with.

The authors of the paper quoted from are confident that the solution of the problem lies in the petrol-electric drive, and they base their conclusions not upon any theoretical considerations, but upon actual trials on the road with 'buses equipped on the petrol-electric system running side by side over the same routes as others fitted with the direct petrol drive.

Many attempts have been made to popularise the mixed system of driving, not only in connection with 'bus traction, but with ordinary automobile work. In some systems, accumulators are used, such as in the Pieper Auto-mixte method, to assist the motor on gradients; others use the electric apparatus merely for starting purposes, and then run on the direct drive; whilst others use electric transmission both for starting and running, but without accumulators. There are several modifications of the latter system, the differences being either in the method of control, or in mechanical details connected with the driving gear or arrangement of the motors.

As the Smith-Stevens arrangement is one of the latest, and is at the time of writing the only one in actual operation under the ordinary every-day conditions of motor-'bus traffic, a brief description of the method adopted may be of interest.

The engine is rated at 30 H.P., according to the R.A.C. rating, having a bore of 110 mm. and a stroke of 140 mm. It is directly coupled, by means of a flexible coupling, to a dynamo fitted with commutating poles, and having a maximum output of 18 KW. when running at 900 R.P.M. The current range of the dynamo is 0 to 250 amperes, and the voltage range 0 to 200 volts. The dynamo is not quite a constant output machine, although it has a falling characteristic, the volts and amperes rising and falling almost in inverse proportion. Two series-wound motors are used for driving the 'bus, each being worm-geared to one of the back wheels, which are mounted on a dead axle. The worm-gear is placed between the wheels and the springs carrying the car-body, so that the two motors are exposed at the side of the 'bus, and are therefore readily accessible. The arrangement of the worm box and housing is such that leakage of oil is practically impossible. For London 'bus traffic the worm ratio is 12/1, and for mail-van and country work generally 16/1, the latter being adopted on account of the better efficiency obtained in hill climbing.

The motors are series wound, each being capable of taking half the full output of the generator when running at a speed of 1,200 R.P.M. By means of a controller they may be connected up in series or parallel, but the series connection is only required in ascending steep gradients. The control is effected by means of two pedals, one of which operates the throttle and the other operates the brake. A third pedal connected with the main switch locks the controller, making it impossible to alter the connections without first breaking the circuit. The speed of the engine is controlled by means of the throttle pedal, which in the top position brings the speed down to about 300 R.P.M., when the dynamo loses its excitation. The car, therefore, can be brought to rest without stopping the engine at all and without breaking any electrical connection. To start up, it is merely necessary to depress the throttle pedal, gradually bringing up the excitation and with it the speed of the motors. A resistance in series with the shunt field of the generator may be varied by means of a small lever on the steering wheel after the manner of the spark advance lever, and by this means the voltage of the generator can be raised above the normal when fast speeds are required. As the motors are series wound, their torque is independent of speed, and full torque can be obtained when crawling along in and out of dense traffic.

The advantages of a drive of this nature, from the passengers' point of view, are readily appreciated by those who have travelled in vehicles equipped on this system. Instead of the sudden jerks which take place on the driver bringing the clutch into operation, the car starts from rest

very gradually, and accelerates easily and almost imperceptibly. Even if the driver presses his starting pedal down suddenly, the self-induction of the generator field is alone sufficient to prevent a sudden start such as would take place if the drive were through a clutch or any other mechanical device.

From the point of view of the general public, the advantages of such a system are the absence of the deafening and irritating noises which are inseparable from the use of the clutch and scrunch or speed-change gear; the absence of the pools of oil which leak from the gear-boxes of the ordinary motor-'bus; and the minimising of the smoke nuisance due to the better conditions under which the engine is running.

From the point of view of the 'bus proprietors, the great advantage is the reduced cost of running and maintenance. It might hardly be expected that the petrol consumption per 'bus-mile would be less with a petrol-electric than with the ordinary direct-geared system of driving, as, although the gear-box, clutch and differential gearing are eliminated, there is the double loss in the dynamos, motors and worm gear. In practice, however, it has been found that the consumption with the petrol-electric drive is lower than with the purely petrol drive. This advantage was at first put down to the fact that in the petrol-electric 'buses the engines were new and in good condition, but comparisons with new petrol 'buses in which exactly similar engines are used, still show that the advantage is in favour of the petrol-electric drive by at least half-a-mile per gallon.

The B.T.-H., Greenwood & Batley, and other continuous-current systems, differ in details only from the foregoing, and not in any essential electrical feature.

The system known as the Hart-Durtnall system, however, is on somewhat different lines. Messrs. Hart & Durtnall have satisfied themselves that the direct drive is more economical than a drive in which electric transmission between the engine and the road wheels is employed; and in their system the electrical apparatus is used only for starting and accelerating, the propeller shaft being coupled directly through an electromagnetic clutch to the engine shaft when the running speed is attained. Their system is really what might be described as the development of a principle patented by Jenatzy and others a few years ago.

In Jenatzy's original patent a field magnet system was coupled up to the engine shaft and revolved round a closed circuit armature—that is to say, an armature closed upon itself on the same principle as an ordinary squirrel cage induction rotor. Whilst the field magnets revolve without excitation there is no torque between them and the armature; but, as the exciting current is gradually increased, the torque between the two is also gradually increased. The Cutler-Hammer magnetic accelerator is somewhat on the same principle, but has the advantage of using mechanical friction in addition to magnetic drag. There are obvious practical limitations to a simple arrangement on the lines of Jenatzy's method, and little or nothing appears to have been done to develop it until the introduction of the Hart-Durtnall arrangement.

In this arrangement the engine is directly coupled to the revolving magnets of a three-phase generator, the armature itself being stationary. A series-wound exciter, also driven from the engine, is connected through the controller with a pair of slip rings on the alternator magnets. The rotor of a three-phase induction motor is attached to the propeller shaft of the vehicle, the three stator terminals being connected to the three armature terminals of the generator through a change-over switch which is used for reversing the direction of rotation. When the engine is run up to speed, the impressed voltage on the motor terminals may be varied by altering the exciting current of the generator. This is done by means of a foot pedal. In such a system as this the trouble arising from the use of commutators is reduced to a minimum, as the only commutator is that on the exciter which carries a small current, and it can be designed with plenty of margin. The propeller shaft carrying the rotor is in a direct line with the engine shaft which carries the revolving magnets and an electro-magnetic clutch is interposed between them. This is brought into operation by the foot pedal. When the generator has its full excitation a further movement of the pedal excites the clutch and cuts off the exciting current to the generator. In this condition the engine is driving the vehicle direct without any loss in electrical transmission beyond the very small exciting current in the clutch.

Such an arrangement would, on the face of it, appear to be more economical than driving through an electrical transmission system; although we still have the loss of energy in the differential gear, and retain any disadvantages which the differential gear possesses. It may be pointed out, however, that there is no loss in the differential on a straight route. As the electric generator and motor are only intended to be in circuit during starting and acceleration, they are able to take very heavy overloads for these short periods. In other words, the machines can be built very much lighter than would be necessary for continuous running. Those, however, who have had the opportunity of riding through London traffic alongside the driver of a motor-'bus, particularly on an electrically-driven motor-'bus, will know that the top speed—that is to say, the direct gear—comes into play very rarely, a very large proportion of the time during which the 'bus is in service being occupied in starting and accelerating. In following up slow traffic a 'bus may be started and stopped several times a minute, and it is obvious, therefore, that under these conditions the electrical equipment must be more liberally designed than one in which sufficient time elapses between consecutive starts to allow of cooling down. The efficiency of the transmission, too, under these conditions is a point which needs to be very carefully considered.

So far as can be ascertained at present, it would appear that there is little to choose between the actual cost of the direct petrol drive and the purely electrical drive, such as is used on the electro-'bus, but the difference in the running conditions of the two systems is very marked. It is claimed, however, that the petrol-electric system can show an advantage of fully 2d. per 'bus-mile over either the simple petrol or accumulator-electric drive.

The advantages of a mixed or electro-mechanical system of driving, are not confined to motor-'buses. Considerable improvement in traffic-handling qualities could be shown on many suburban lines by the conversion to either steam-electric, petrol-electric or a Diesel-electric system.

PROCEEDINGS OF INSTITUTIONS.

The Faraday Society.

Recent Developments in Electric Induction Furnaces.

In a very admirable paper read before the Faraday Society at the June meeting, held on the 23rd ult., Mr. J. Härdén, of the Gröndal Kjellin Co., Ltd., dealt generally with some interesting physical phenomena associated with all types of induction furnaces, and particularly with the modified form of the Kjellin furnace, known as the Röchling-Rodenhauser furnace.

It will be remembered that in the original Kjellin furnace, the circular trough constituting the melting bath forms the closed secondary of a step-down transformer. This type has been found ideal for making crucible steel in, because the high price of the product enables quite pure material, scrap or ore to be used, so that the furnace is merely a melting and not a refining furnace. Moreover, only small charges—rarely more than 1½ tons—are necessary in the case of crucible steel. For making rail or similar steel, however, much larger units must be used, and the charge must consist of the ordinary materials, for otherwise competition between the electric and the open-hearth furnace would be impossible, and there the pure induction type has been found to require modification, as the power factor of a transformer furnace is lowered if in consequence of its section being too large its resistance becomes too low. To get over the difficulty by increasing the diameter of the ring is likewise impossible to any degree, because in that case the distance between primary and secondary becomes too great and the power factor is again lowered. A combination induction and resistance furnace has, therefore, been devised by Messrs. Rodenhauser & Schönawa for the Röchling Iron and Steel Works, at Völklingen, Germany, suitable for making rail and similar steel in 5 to 7-ton lots from a material made from inferior ores and decarburised in a converter, and containing 0·1 to 0·2 per cent. sulphur and 0·05 per cent. or more phosphorus. The modified furnace consists of a double, instead of a single, ring-shaped bath, forming a double secondary of the transformer, the two halves

communicating with one another by means of a wide channel that forms a square or rectangular hearth, and has doors back and front. In the case of a three-phase furnace, three such ring-shaped baths are used adjacent to one another. It is the central hearth which forms the "resistance" side of the furnace, and the extra current it takes is derived from a few turns of heavy secondary winding placed around the primary on each leg of the core. Mr. E. Ristori, in the discussion on the paper, claimed that the new furnace is practically a resistance furnace, and that only the adoption of the resistance principle makes it possible for an electric furnace to refine as well as to melt. This is no doubt partly the case, but not entirely. In the first place, about one-half the power absorbed passes through the centre channel, and one-half through the rings. Secondly, and this is an important distinction, the "electrodes" consist not of carbon, as in the Héroult or Keller furnace, which takes part in the furnace reactions and is gradually consumed, but of a compound of magnesite and dolomite (applied, mixed with tar, over the surface of corrugated steel plates), which conduct only when hot, like a Nernst filament, and which are neutral as far as the bath of metal is concerned. The combination furnace, therefore, still retains the special advantage of the induction furnace, that no foreign materials are introduced (the "electrodes" being practically non-corrodible), and the melt takes place in a neutral atmosphere, while it also acquires the valuable feature of arc and resistance furnaces, by which the slag is obtained in a sufficiently liquid condition.

The operation of the combined furnace is as follows: The lining of burnt magnesite or dolomite, mixed with tar, having been stamped in hot and the tar burnt out, a charge from a Bessemer converter is run into the furnace. The carbon and silicon should be removed in the converter, leaving the phosphorus and sulphur to be dealt with in the electric furnace. Calcined lime, containing about 6 per cent. magnesia, is then added to form a slag, fluorspar being sometimes also added for fluxing, while plate scale from the rolling mill is added for further decarburising. If there is excess of oxygen in the charge, the slag will remove the phosphorus very readily, and it is then cooled by adding cold lime, and when viscous, drawn off by slightly tilting the furnace. Ferro-silicon or carbon—depending on the price of the former, which is preferable—is then added to remove excess of oxygen, in the form of silica or carbon monoxide, as the case may be. A fresh slag of lime is now added for the desulphurisation, and the temperature of the furnace raised. The oxygen is also driven out in this operation, partly by adding more ferro-silicon and mill scale, and partly by oxidising the calcium carbide which is formed in the furnace. The formation of this calcium carbide *in situ*, at a temperature lower than one would have thought necessary, is a matter of some interest, since in some of the electric furnaces it is actually added on account of its deoxidising properties. Finally, the temperature of the bath is still further raised until no more gas bubbles are seen to leave the charge, and then a test piece is taken out and forged, some coke being added if this is found to be over soft. The whole operation takes from 1½ to 2 hours, though the heating may be prolonged with advantage, and a material containing up to 0·1 per cent. phosphorus and 0·1 per cent. sulphur can be refined to 0·006 per cent. phosphorus and 0·02 per cent. sulphur. The power consumption is from 120 to 150 KW. per ton of steel, if the charge comes molten from the converter, and the power factor of furnaces at present working varies from 0·7 to 0·85. The largest "combination" furnace now actually working, at Völklingen, has a capacity of about 4 tons, but furnaces up to 8 tons capacity or more are in course of construction at the same works and at Krupps, at Essen.

The quality of the steel produced would appear to be very satisfactory; in particular it is, as would be expected, very uniform in structure and composition. The Prussian State Railways are ordering considerable quantities of rails made in the Völklingen furnace for points and crossings, and these rails generally are stated to command 25s. to 45s. a ton more than for ordinary rails.

Mr. Härdén in his paper describes some very interesting physical effects which he and others have observed in electric furnaces. One of these is called the "pinch" effect, and it has been noticed in the resistance and arc types of furnaces. If the current density in a bath of molten material is raised above a certain point, any accidental contraction at some point in the bath will become violently accentuated by the mutual attraction of the elements of metal for one another, due to the flow of current, so that the metal on either side of the "pinch" swells up above the average level of the bath, and may even momentarily break the circuit at that point. Observations on this effect have been made in the 60-KW. experimental Kjellin furnace erected at Battersea, and it has been found to occur in the induction furnace, but only when the charge is considerably less than that normally applied.

Another interesting observation that has been made is that if the resistance curve is taken across the terminals of an induction furnace, by simultaneous observations at various loads of voltage and current, starting with a cold ring of iron for charge, this curve makes a decided drop at a certain point just before the melting of the iron. This is because the permeability of the iron—and hence the strength of leakage field—is rising rapidly during the heating up to about 840° C., when it drops very quickly, reaching zero at about 920° C. In the meantime the ohmic resistance of the secondary iron circuit is also increasing, although more slowly than the change in permeability; therefore the voltage will again rise until heat equilibrium is attained.

These, and various other novel points in connection with the working of induction furnaces and the electric and magnetic properties of molten iron, are going to be investigated (so we are promised by Dr. J. A. Harker) in the National Physical Laboratory to which the Gröndel Kjellin Co. last year presented a small experimental induction furnace, and the results will be awaited by all electro-metallurgists with keen interest.

Acid-Resisting Electric Furnace Products.

At the same meeting, M. Jouve, in a communication sent from Paris, described and showed specimens of some new acid-resisting alloys which have been successfully used for the treatment or passage of nitric, hydrochloric, sulphuric and other acids and corrosive reagents, and which in many instances should form a cheap substitute for platinum. The alloys, which carry high percentages of silicon, are made in the electric furnace.

Physical Society of London.

At the meeting held June 12th, 1908, a paper by Messrs. E. Bellini and A. Tosi on "Experiments on a Directive System of Wireless Telegraphy" was read by Mr. Tosi. An abstract of this will be given in a later issue.

A paper entitled "On the Resistance of a Conductor of Uniform Thickness whose Breadth Suddenly Changes, and on the Shape of the Stream-lines," was read by Prof. C. H. Lees.

A knowledge of the resistance of a conductor whose section suddenly changes is of considerable practical importance, but mathematical difficulties have prevented an exact solution of the problem. Lord Rayleigh has given an approximate solution of the case in which a cylinder of circular section is joined at one end to the plane surface of a large conducting solid; and Prof. Hicks has solved the case of a wire of small diameter ending in the surface of a conducting sphere. The mathematical difficulties of the problem disappear if the conductors are of rectangular section and one dimension, *e.g.*, the thickness remains constant while the breadth suddenly changes and the two are joined together either with their axes or with two sides collinear. The paper shows that the resistance between two transverse sections through points situated at considerable distances from the change of section, on opposite sides of it, is equal to the sum of the resistances of the portions of conductor between each of the two sections and the change of section, each considered as part of an infinite length, plus the resistance of a length of either conductor equal to its breadth multiplied by an expression given.

A paper on "The Inductance of two Parallel Wires" was read by Dr. J. W. Nicholson. When direct and return currents flow in two wires of great length, and the alternation is not rapid, the effective self-induction per unit length of the system may be calculated readily by simple integration. If the wires have radii a, b and permeabilities μ, ν, and if c be the distance between their axes,

$$L = 2 \log c^2/ a b + \tfrac{1}{2} (\mu + \nu).$$

This formula is often of little practical use when the frequency of alternation is several thousands per second. Such frequencies are of constant use in practical work. For example, in the measurement of small inductances by Mr. Campbell's method it is necessary to employ long leads, in order to keep them at some considerable distance from the bridge and other circuits. The self-induction of these leads must be small, and a calculation of its value is very desirable. The general case presents very great mathematical difficulty, but the solutions given in the paper appear to include most cases of practical utility.

THE CONGRESS OF THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

Rail Corrugation.

(*Abstract of Lecture given by* Prof. C. A. Carus-Wilson, Assoc.M.Inst.C.E.)

Speaking generally, it may be said that, with some exceptions, to which I will allude later on, corrugation is accompanied by a cutting of the check of the opposite rail.

When wheels and rails are new there is a clearance, generally of about ¼ in., between the flange and the check on both sides. Any side pressure on straight or curve is then taken by the throat of the flange bearing on the head of the rail. The flange cannot come in contact with the check until considerable wear has taken place.

With a view to investigating this matter, I have constructed a model, which consists of a four-wheel truck with brass wheels 2½ in. in diameter, whose centres are 4½ in. apart. There is an equaliser suspension by which a weight, hung from a central support, is distributed equally over the four wheels. One wheel on each axle is keyed to the shaft, the other being a loose wheel held

in place by a sleeve, and able to be coupled up, either rigidly or flexibly as desired.

The truck is first loaded with a weight of 14 lb., a rigid coupler inserted in the loose wheel, and the mark set opposite a point A at the right-hand end of the track. The truck is then made to travel over the track until the wheel has made three complete revolutions, and the mark has met at a point B. The truck is taken back, and the mark placed opposite point A as before. If the flange of the coupled wheel is now pressed hard against the rail while the truck is made to travel forwards, it is found that the mark will meet the rail at a point C, which lies beyond point B, the distance B C being about 2 per cent. of A C. Owing to the side pressure the flange bites the rail on a line of contact whose diameter is greater than that of the tread of the wheel; the wheel tends to run on this line of contact, and the tread is forced to skid on the head of the rail in consequence. The result is that the motion is a combined roll and skid, the distance A B representing roll, and B C representing skid. The skidding, however, is continuous, and for any part of A C covered, say, the hundredth of an inch, the same proportion, namely, 2 per cent., is skid. The two wheels being rigid on one side, both skid an equal amount.

It thus appears that when the flange is forced against the side of the rail the wheels are made to skid a certain percentage of the distance travelled. Having ascertained this fact, the next step was to find out whether any such skidding took place on an actual tramway track. For this purpose I conducted a series of tests at Croydon on a four-wheel double-deck car with Mountain & Gibson truck equipped with two Westinghouse No. 200 motors, weighing, with five passengers, 7·8 tons. The truck had a wheel base of 6 ft., with British Griffin chilled-iron wheels. A bicycle gear wheel with 68 teeth was fixed on one of the axles and connected by a chain drive to a spur wheel with 14 teeth secured on the floor of the car. A Harding speed counter was attached to the spur wheel by which the revolutions of the axle could be measured. The circumference of each wheel on this axle was measured with a steel tape and checked by callipering, the result being exactly 95¾ in. in each case, the two wheels having the same diameter.

A section of straight and nearly level track was chosen on the road between Croydon and Purley. There were here two lines of rails, badly corrugated for the greater part of the distance. The track is of standard gauge with macadam sides, and the rails, weighing 95 lb. per yard, are laid on a 6-in. bed of concrete. Two trips were made each way with the track very dry and two trips each way after a heavy rain storm, the track being then very wet, but not greasy. The results are given in the following table:—

—	Condition of track.	Mean counter revolutions.	Skid in counter revolutions.	Skid in % of distance covered.	Mean speed, miles per hour.
Down trip	Dry	1,516	65	4·1	11·2
,,	Wet	1,535	46	2·9	11·1
Up trip ...	Dry	1,522	59	3·7	14·4
,, ...	Wet	1,547	34	2·1	14·0

From these experiments it appeared that, when a car travels along a tramway track, the wheels skid upon the head of the rails in the same way as they do in the model.

It remained to be seen in what way the skidding, which had been shown to take place, could produce corrugation. For this purpose further experiments were made on the model. In order to get a definite amount of skid that should be independent of possible variations in the side pressure exerted, a metal fillet was inserted against one of the rails in such a way as to lift the keyed wheels off the rail and force them to roll on the outside of their flanges. The diameter of the outside of the flange is about 9 per cent. greater than that of the tread, and a pure roll on the flange would correspond with the distance A D on the rail, where B D is about 9 per cent. of A B which represents three complete revolutions on the tread.

If the loose wheel is now fitted with a rigid coupler, the motion of the coupled wheel will be a roll and a skid, and of the keyed wheel a roll and a slip, the proportion of skid to slip depending upon the relative coefficients of friction, but the sum of the two always being equal to B D or 9 per cent. of A B. With a total weight of 42 lb., that is, 10·5 lb. on each wheel, the coupled wheel skids about 8 per cent. The skidding remains quite uniform and continuous as before.

If the coupler is removed from the notch and placed on one side of the stud, the loose wheel is at liberty to roll freely on the rail, and the coupler tends to draw away from the stud under the action of a definite force. This force can be made apparent if the rigid coupler is replaced by a spring coupler fixed in the notch. Whichever way the truck is pushed the spring is bent, indicating a tendency to twist the coupled wheel relatively to the axle. The angle through which the spring is bent represents the torsion required to overcome the adhesion between the tread of the wheel and the rail.

From these experiments it is evident that when the flange of a car wheel grinds against the rail in such a way as to cause skidding, the axle will be twisted until the torsion is sufficient to make the tread of the mate wheel skid on the rail, the elastic twist of the axle representing the bending of the spring in the model.

So far, however, the skidding is quite continuous, and there is no indication of any intermittent action such as could produce corrugation. But the experiments with the model have been carried out under conditions differing in one very important respect from those of actual practice. The rails have been quite clean. It remains to be seen what is the effect of making the rail surface rough as it is in practice. For this purpose a little sand may be sprinkled over the surface of the rail. If the truck is now pushed along the track an entirely new effect is produced; the coupled wheel, instead of moving uniformly as before, now advances with a series of jerks at regular intervals.

The action is as follows: When the torque on the spring has increased to a certain amount the force of adhesion is overcome and the wheel skids, turning meanwhile about its own axis, so that the whole force of the skid is concentrated over a limited area on the rail surface. In skidding the wheel grinds through the grit on the surface of the rail and comes into contact with clean metal; there is thus a large and sudden reduction in the coefficient of friction and the wheel flies back under the influence of the spring through a considerable angle. The result is that the subsequent motion of the wheel upon the rail will be a pure roll while the spring is being again deflected. When the limit of adhesion is reached the wheel again skids and the process is repeated, the motion thus consisting of alternate rolling and skidding. The addition of the grit has made the skid intermittent, whereas formerly it was continuous. When the surface of the rail is clean there is no sudden breaking down of the adhesion which is required to make the skid intermittent. This effect is not due to the increased torsion on the spring consequent on the increase in the coefficient of friction; for the same torsion can be obtained with a clean rail by increasing the weight, when the skid remains continuous.

The distance apart of the marks on the rail, or the pitch of the corrugations, necessarily depends on the action above described. When the coefficient of adhesion, the weight on the wheel and the dimensions of the axle are fixed, the limiting amount of twist measured, say, in fractions of an inch at the rim of the wheel is also fixed. Now the skid is a definite per cent. of the distance travelled, say, x per cent., and when corrugation takes place the skid between any two marks is accumulated in the twist of the axle, hence x per cent. of the pitch must equal the limiting twist on the axle. Thus if the skid is 2 per cent. and the limiting twist 0·02 of an inch, the pitch would have to be 1 in. It is necessary, therefore, to ascertain whether this relation holds good in practice.

With the car used in the Croydon tests the weight on each wheel was 4,370 lb., the diameter of the axle 3¾ in. and the distance between wheel hubs 48 in. Taking the modulus of transverse elasticity for the axle at 14×10^6, and the coefficient of friction at 0·4, the twist measured at the rim of a wheel 31 in. diameter will be 0·073 in. For a skid of 3 per cent. the pitch of the corrugations would, therefore, have to be 2·4 in. On the Croydon tramways the pitch of the corrugations on the straight varies from 2¼ to 2⅝ in.

During the process of corrugation the axle is subject to torsional vibration, and in order that the skidding may continue to take place intermittently the twisting force must be applied rhythmically with a time interval equal to the period of vibration of the axle. Hence the time occupied in covering the distance between two successive skids will be a constant quantity for any given wheels and axle. It follows, therefore, that the pitch of the corrugations will depend not only upon the skid, but also upon the speed of the car. Thus, if the mean speed is 12 miles an hour for corrugations having a pitch of 2½ in., when the speed is 24 miles an hour the pitch will be 5 in. This increase of pitch with speed has been noticed by many observers.

It would seem then that the pitch is determined in the first place by its relation to the per cent. skid and the limiting twist on the axle, and in the second place by the speed, and that corrugation cannot take place unless the two sets of conditions are to some extent in agreement. Thus, in the case just quoted, the skid at 24 miles an hour must be half that at 12 miles an hour, that is, if the skid is halved the speed must be doubled.

The side pressure of the flange on the rail that is necessary for the production of corrugations is caused, on the straight, by irregularities of gauge and level which make the car lunge from side to side and bear over against one rail or the other. This accounts for the irregular distribution of corrugations along the track, first on one side, then on the other, in long or short stretches with smooth parts in between.

The difference of length between the inner and the outer rail on a curve gives rise to a skidding, or slipping, quite apart from that due to the grinding of the flange on the rail. Speaking generally, however, it may be said that the speeds on small radius curves are, as a rule, too low to admit of corrugations being formed.

The pitch of the corrugations on a curve is generally less than on the straight. Thus, in the case of a car which produces corrugations on the straight having a pitch of 2·4 in. with 3 per cent. skid, on a curve of 500 ft. radius, the skid on the outer rail due to the difference in the length of the inner and outer rails will be about 0·9 per cent., making a total of 3·9 per cent. Now, the pitch is inversely proportional to the per cent. skid, so that the pitch of the corrugations on the curve should be about 1·9 in. Observation shows that the pitch on curves is reduced about in this proportion.

Although corrugations are, in my opinion, generally caused by the grinding of the flange on the rail, this is not the only way in which they may be produced. A similar action may be set up if for any reason the wheel should be forced to run on its flange. This often happens at points and crossings, the tread of the rail being lifted clear off the rail head, when corrugations may frequently be observed on the opposite rail. The same thing happens when the rail has been badly worn and the flange actually touches the bottom of the groove. I have noticed cases of this kind, and corrugations invariably appear on the other rail immediately opposite the marks made by the flange in the groove.

For more than 10 years past corrugations have been noticed on some Indian railways, especially on the Eastern Bengal State Railway.

Through the kindness of Sir Alexander Rendel and Mr. F. E. Robertson I was supplied with a sample of the brick boxing taken from a section of the Eastern Bengal State Railway, where corrugations are very pronounced. Some of the brick was crushed, making an exceedingly sharp and gritty powder. The model was arranged as before with a spring coupler in the loose wheel. So long as the rail remained clean the skidding was quite uniform as the truck was pushed along the track. When a little of the brick powder was scattered over the rail the skidding immediately became intermittent, indicating clearly the part played by the brick boxing in the formation of corrugations.

The investigations outlined above appear to show that the following conditions are necessary for the formation of corrugations on grooved rails:—

1. As regards the track: (*a*) Irregularities in gauge or level; or (*b*) curvature; or (*c*) a packed groove. 2. As regards the rails: (*d*) Surface rough with sand or gritty dust. 3. As regards the rolling stock: (*e*) Wheels with check-cutting flanges. 4. As regards traffic: (*f*) A critical speed.

Corrugations cannot be formed unless conditions 1, 2, 3 and 4 are all present at the same time—that is, peculiar conditions must exist simultaneously in the track, the rails, the rolling stock and the speed, and the absence of any one of these conditions will prevent corrugations being formed.

NEW PATENTS APPLIED FOR, 1908.

Compiled expressly for this journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool and Bradford, to whom all inquiries should be addressed.

¥ 14,295. "Improvements in systems of electric distribution employing low-voltage batteries on consumers' premises." A. M. TAYLOR. July 6th.

14,316. "Improved mouthpiece for telephones and speaking-tubes." G. J. SMITH. July 6th.

14,328. "Improvements in underground conduit systems for electric railways." A. H. ANGLE. July 6th. (Complete.)

14,330. "Control mechanism for attachment to the handle-bars of motor cycles for actuating spark advance and switch contact and exhaust and valve lift or throttle." W. F. COX. July 6th.

14,332. "Electric signal transmission arrangement." H. and P. VAN DEN BOSSCHE. July 6th. (Complete.)

14,340. "Improvements in induction supply meters for polyphase electric currents." H. ARON. July 6th. (Complete.)

14,356. "Improvements in means for preventing undue wear of electrical leads." F. W. RUSSELL. July 7th.

14,359. "Electrically-operated automatic advertising device." I. H. PARSONS and R. L. ACLAND. July 7th.

14,380. "Improvements in the control of electricity." J. R. QUAIN and W. ADAMS. July 7th.

14,401. "Combined telephone and telautograph exchange systems." F. RITCHIE. July 7th. (Complete.)

14,411. "Improvements in or relating to electric lighting attachments or the like." A. J. BOULT. (Benjamin Electric Manufacturing Co., U.S.) July 7th. (Complete.)

14,425. "Improvements in or relating to telephone systems." E. A. GRAHAM. July 7th. (Complete.)

14,431. "Improvements in and relating to apparatus for electrically controlling mechanism at a distance." C. G. LOHAY. July 7th. (Complete.)

14,436. "Improvements in and relating to the manufacture of filaments for incandescent electric lamps." BRITISH THOMSON-HOUSTON CO., LTD., I. W. HOWELL and H. H. NEEDHAM. July 7th.

14,455. "Improvements in contact breakers in magneto-electric machines." H. STEPHENS. July 8th.

14,468. "New or improved automatic electro-magnetic switch or cut-out for disconnecting charged conductors in overhead systems of electric traction or the like." W. BARRACLOUGH. July 8th.

14,474. "Improvements in electrical measuring instruments." O. D. LUCAS and E. R. CLARKE. July 8th.

14,478. "Improvements in tiles, electric light casing, picture rails and the like for fixing to or on a wall, ceiling or partition." A. J. HOLLICK. July 8th.

14,480. "Improvements in trolley-heads for electric traction." G. B. HOLMES and A. D. ALLEN. (Date applied for under Sec. 91 of the Act, August 7th, 1907, being date of application in United States.) July 8th. (Complete.)

14,488. "Process for rapidly mounting filaments and for electrically soldering them in electric incandescent lamps with metallic filaments." S. MARIETTI. (Date applied for under Sec. 91 of the Act, July 8th, 1907, being date of application in Italy.) July 8th. (Complete.)

14,502. "Improvements in metallic-filament lamps bent by positive tension." W. MAJERT. (Date applied for under Sec. 91 of the Act, June 13th, 1908, being date of application in Germany.) July 8th. (Complete.)

14,513. "Improved starter for electric motors." D. TIMAR and C. VON DREGER. (Date applied for under Sec. 91 of the Act, August 19th, 1907, being date of application in Germany.) July 8th. (Complete.)

14,518. "Improvements relating to the control of induction motors." S. H. FIELDEN and RHODES MOTORS, LTD. (Application for Patent of Addition to No. 8,966/07.) July 8th.

14,537. "Improvements in and relating to electric heating devices." BRITISH THOMSON-HOUSTON CO., LTD. (General Electric Co., United States.) July 8th.

14,545. "Improvements in or relating to electric cable conductors." W. E. HITCH. (Application for Patent of Addition to No. 13,704 of 1908.) July 8th.

14,554. "Improvements in electrical vulcanising apparatus." P. ALLMAN and G. W. T. LEESON. July 9th.

14,594. "Improvements in dynamo electric generators." BRITISH THOMSON-HOUSTON CO., LTD. (General Electric Co., United States.) July 9th.

14,597. "Improvements in or connected with electrically actuated devices for locking the doors of railway carriage, tramway and like vehicles." S. A. M. ROSE and C. F. KENNEDY. July 9th. (Complete.)

14,609. "Improvements in electric galvanic batteries." G. SCHAULL. July 9th.

14,615. "Improvements in dry cells for generating electricity." H. HUNTE, July 10th.

14,656. "Improved device for earthing or metallic continuity of slip sockets conduits for electric wires." G. EVANS. July 10th.

14,695. "Improved current collector for use in electric traction systems." A. WEST. July 10th.

14,698. "Improvements in carbon brush holders for magneto electric igniters." The firm of R. BOSCH. (Date applied for under Sec. 91 of the Act, April 21st, 1908, being date of application in Germany.) July 10th (Complete.)

14,699. "Improvements in electric oscillographs and the like." BRITISH THOMSON-HOUSTON CO., LTD. (General Electric Co., United States.) July 10th.

14,700. "Improvements in and relating to the regulation of motors" BRITISH THOMSON-HOUSTON CO., LTD. (General Electric Co., United States.) July 10th.

14,701. "Improvements in and relating to electric regulating devices." BRITISH THOMSON-HOUSTON CO., LTD. (General Electric Co., United States.) July 10th.

14,741. "Improvements in electrically operated rock drills or the like, specially applicable for stoping." J. KNIGHT. July 11th.

14,763. "Improvements in collectors for electrical machines." AKTIEN-GESELLSCHAFT BROWN, BOVERI & CIE. (Date applied for under Sec. 91 of the Act, November 9th, 1907, being date of application in Germany.) July 11th. (Complete.)

14,566. "Non-screw capping and casing for electric wires and cables." E. S. FARDON. July 9th.

14,574. "Improvements relating to electric and other clocks." T. H. PARKER. July 9th.

14,579. "Mode of and apparatus for electrically sounding a horn." A. H. NICHOLSON. July 9th. (Complete.)

14,773. "Improvements in plugs for supplying electric power." G. COOPER and F. C. SHARP. July 11th.

14,776. "Improvements in automatic electric projectile igniters operated by admission of water." P. SCHWENSKE. July 11th. (Complete.)

14,784. "Improvements in electrically blocking a single-line railway." SIEMENS BROS. & Co., LTD. (Siemens & Halske Actiengesellschaft, Germany.) July 11th. (Complete.)

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1906.

ELECTRIC ARC LAMP. W. J. Davy. 12,257. May 25th.

1907.

ELECTRIC SIGNALLING. R. A. Fessenden. 6,203. March 14th.

ELECTRIC FURNACES. The Gröndal Kjellin Co. and J. Harden. 8,445. April 11th.

INCANDESCENCE BODIES SPECIALLY ADAPTED FOR LIGHTING AND HEATING PURPOSES. Allgemeine Elektricitäts-Ges. 8,947. April 17th. (Date applied for under International Convention, April 19th, 1906.)

MEANS FOR ELECTRICALLY OPERATING APPARATUS. H. S. Hatfield. 11,541. May 17th.

METHOD OF AND MEANS FOR AUTOMATICALLY CONTROLLING THE POINTS OF ELECTRIC TRAMWAYS OR THE LIKE. M. Rathbone, H. Fielding and A. P. Latham. 13,760. June 14th.

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SECONDARY BATTERIES. F. L. Oppermann. 14,255. June 20th.

DYNAMO-ELECTRIC MACHINES OF THE NEUTRALISED CONDUCTION TYPE. V. A. Fynn. 15,151. July 1st.

ARC LAMPS. H. S. Hatfield and F. M. Lewis. 16,053. July 12th.

SAFETY ELECTRIC APPARATUS FOR LIGHTING MINERS' SAFETY LAMPS. J. C. Bowie and J. H. Phelps. 16,145. July 13th.

FIXING THE TERMINALS AND CONTACT PIECES OF ELECTRICAL FITTINGS. H. Bevis and F. M. Chapman. 16,188. July 15th.

PRINTING TELEGRAPHS. Siemens Bros. & Co. and G. S. Grimston. 16,334. July 16th.

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ELECTRIC INSULATING MATERIAL. British Thomson-Houston Co. (General Electric Co., United States.) 18,111. August 9th.

MULTIPLE-CONTACT SWITCH OPERATING FROM A DISTANCE AND A CONTROLLER THEREFOR. J. B. M. P. H. Roslin D'Ivry. 18,332. August 13th.

CONTROL OF INDUCTION MOTORS. Rhodes Motors, Ltd., and S. H. Fielden. 18,956. August 22nd.

HIGH-TENSION IGNITION PLUGS FOR INTERNAL COMBUSTION ENGINES. R. Fox, W. Fawcett and W. Fawcett, jun. 19,190. August 26th.

FRICTION PERMEAMETER FOR TESTING MAGNETIC MATERIALS. W. H. F. Murdoch and A. T. J. Kersey. 19,670 September 3rd.

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DYNAMO-ELECTRIC MACHINES. J. Burke. 21,584. September 28th. (Date applied for under International Convention, February 4th, 1907.)

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1908.

ELECTRICAL POWER TRANSMISSION SYSTEMS. Allgemeine Elektricitäts Ges. 9,977. May 7th. (Date applied for under International Convention, June 8th, 1907.)

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AERIAL CONDUCTOR FOR WIRELESS TELEGRAPHY AND TELEPHONY. S. Eisenstein. 67. January 1st.

SPARKING PLUGS FOR INTERNAL-COMBUSTION ENGINES. R. B. Ransford. 143. January 2nd.

REGULATING APPARATUS FOR ALTERNATING-CURRENT CIRCUITS. W. H. Thompson. 1,159. January 17th. (Date applied for under International Convention, February 2nd, 1907.)

APPARATUS FOR RECEIVING UNDAMPED ELECTRIC OSCILLATIONS. O. Scheller. 4,843. March 3rd. (Date applied for under International Convention, March 4th, 1907.)

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